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COSTA RICA:
LOAD MANAGEMENT PROJECT

PHASE I: PLANNING

Final Report

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EXECUTIVE SUMMARY

In recent years, Costa Rica's Instituto Costarricense de Electricidad (ICE) has experienced a steady rise in evening peak demand, mainly because of domestic and rural demand for electricity for cooking and lighting. Original plans (as of 1987) to meet this growing demand had to be modified recently, as they were based on a projected growth in demand of 5.5 percent annually. In fact, recent statistics indicate that peak demand is rising much more quickly, at a rate close to 10 percent annually.

As a result ICE has decided to install gas turbines to provide peak capacity and energy during the dry season (see Exhibit i). The turbines and the fuel they use will be imported, hampering the government's efforts to deal with Costa Rica's debt situation. Until the first gas turbine becomes operational in 1989, however, the country will have to rely on ICE's hydrosystem, constrained by a series of dry seasons, and its inefficient and unreliable thermal power units. Roughly 50 MW of power are imported from Honduras each year, but this amount cannot be increased because the transmission lines are operating at full capacity.

To minimize new power generation and transmission investments, ICE is considering a short-term load management project that would reduce peak loads.

PROPOSED PROJECT

Study Team

At ICE's request, USAID/San Jose and AID/Washington co-funded this study to design and implement a pilot load management project, using the AID's Energy Conservation Services Program (ECSP). RCG/Hagler, Bailly, Inc., ECSP prime contractor, subcontracted part of the study to FPL Qualtec, the consulting subsidiary of Florida Power and Light.

Project Focus

The focus of the study was the potential for demand/load management and control options that would reduce peak load growth and thus result in capital savings.

According to the load analysis performed in this study, the annual load factor for Costa Rica's system is around 59-60 percent. The reasons for this low load factor are revealed by examining the daily load curves.

The load curve for a typical day is marked by two peaks; the morning peak, which is slightly lower, generally occurs between 10:00 a.m. and 12:30 p.m., and the evening peak occurs between approximately 5:00 and 8:00 p.m. (see Exhibit ii). The major contributor to the two peaks is the substantial use of electricity for cooking in households.

The two peaks coincide with meal preparation times. An energy end-use survey conducted in 1983 reported that nearly 43 percent of all households in the sample used an electric range for cooking, and an additional 5 percent of households used an electric hot plate. Furthermore, the survey found that nearly 68 percent of all urban households used electricity for cooking, while in rural households only 23 percent used electricity for cooking.

Available data from ICE suggests that after cooking, the primary contributors to the evening peak are the household load (lighting, TV, appliances), street lighting, water pumping, high-load-factor industries that work two or three shifts, and convenience retailing enterprises/shops that operate into the evening and early night-time hours.

Unfortunately, data do not exist to facilitate a breakdown of the hourly load curve into its constituent customer segment components.

Load Management and Load Control

Load management can be broadly defined as the deliberate control or influencing of customer electrical loads (levels, and time-of-use pattern).

Exhibit i

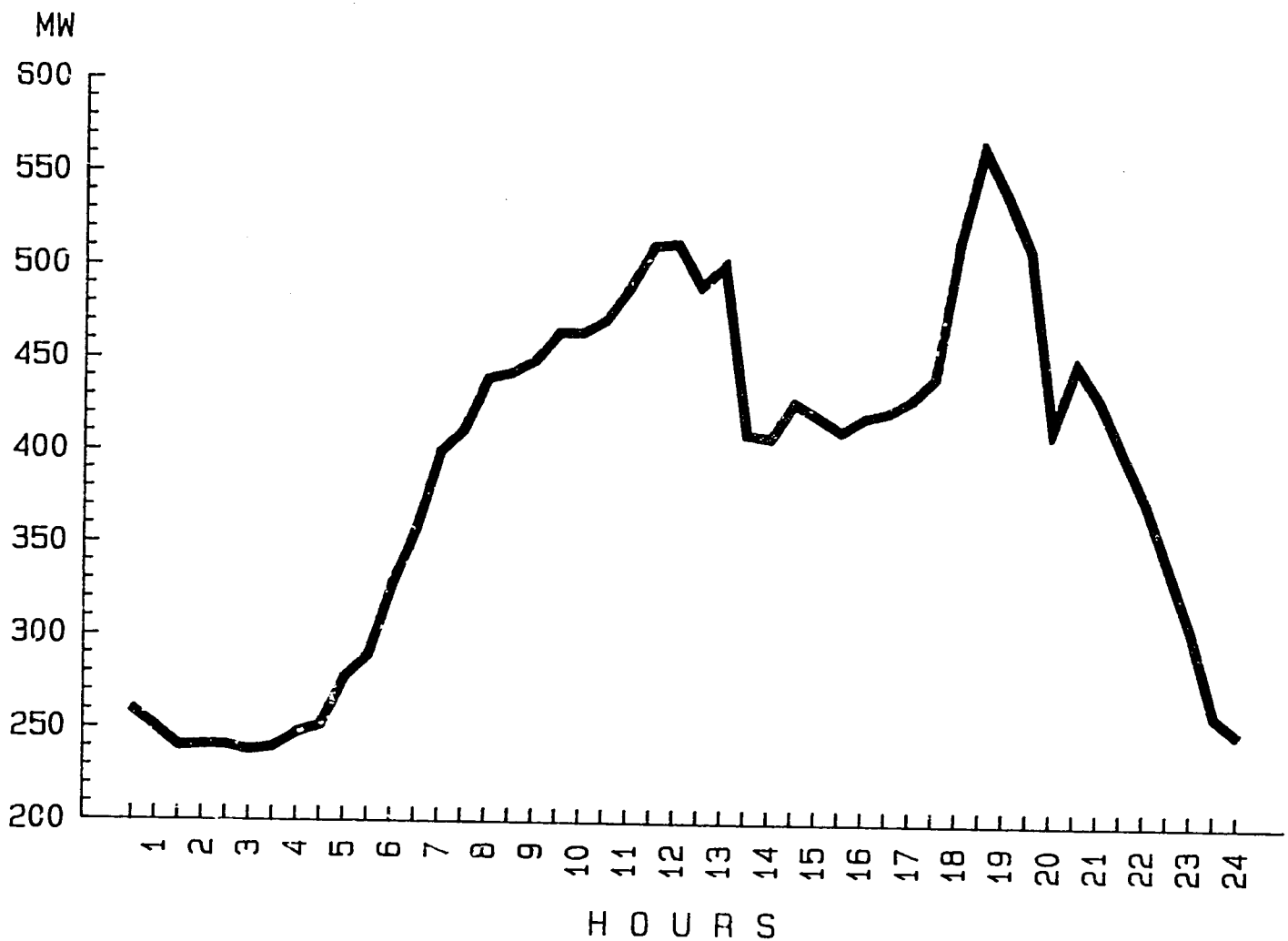
Revised National Generation Expansion Plan
(as of February 1988)

Year	Plant Name	Capacity	Type
1990	Thermal	3x 36 MW	Gas turbines
1991	Thermal	36 MW	Gas turbine
1992	Miravalles-I	55 MW	Geothermal
1993	Sandillal	32 MW	Hydro
	Thermal	36 MW	Gas Turbine
1994	Miravalles - II	55 MW	Geothermal
	Toro I & II	24 + 66 MW	Hydro
1995	Thermal	36 MW	Gas Turbine
1996	Angostura	177 MW	Hydro
1997	Miravalles - III	55 MW	Geothermal
1998	-	-	-
1999	Siquirres	154 MW	Hydro
2000	Miravalles - IV	55 MW	Geothermal
Total 10 years		**889 MW**	

Source: ICE

Exhibit ii

Load curve for 1986 peak day (December 11)



Source: ICE

Broadly speaking, there are two classes of strategies for carrying out load management: direct load control, and indirect load control.[1] Direct load control involves the physical switching on and off of end-use devices/loads by the utility. Indirect load control involves customer control of loads in response to price signals.

The simplest forms of direct load control entail the use of fuses, time switches, appliance interlocks, and other types of demand limiters that do not require remote activation by the utility. In contrast, appliance cycling programs are activated and controlled by the utility; the most common of these involve the on and off cycling -- during times of generation (or network) deficiencies -- of residential water heaters and air conditioners, and C&I central air conditioning systems and resistive heating. In terms of hardware, direct load control programs require a load controller on the customer premises that can switch the load on or off as required, and a communication system linking the utility dispatcher and the load controller.

Examples of indirect load control include demand charge tariffs (where billing demand is measured as coincident with system peak), time-of-use tariffs, super-off-peak rates, and dynamic tariffs.

The ultimate goal of load management is to alter customer load shapes in a manner that generally results in one or more of the following: improvement in load factors, reduction in the need for peaking capacity, and higher utilization of more efficient baseload generation plants. The combined impact of these results should be to lower the average cost of electricity to participants.

Customer Segments

Restraining Cost Rica's electrical cooking load by a load management program -- direct load control, pricing, or even energy storage -- is not practical in the short term. Meal times are dictated by the daily pattern and rhythm of work, and by leisure habits. Most households are unlikely to change this pattern significantly. The most effective way to shave the cooking-related peak may be by encouraging fuel substitution and restricting the use of electric cookers (which can be done by the electric companies themselves --

1 A third strategy, energy storage, is not particularly relevant in the present context (short-term results).

ICE, Compania Nacional de Fueza y Luz, or CNFL -- or through taxation). This would involve a switch from electricity-based cooking to LPG-fired cooking. A careful assessment is needed to determine whether a combination of pricing incentives (for LPG) and tax rebate incentives to promote the purchase of gas ranges would be in the long-term interest of the nation. The Direccion Sectorial de Energia (DSE) is conducting research on this topic at present.

Most of the load management and control strategies recommended in this report focus on options targeted to the large commercial and industrial (C&I) customers in Costa Rica because they -- unlike residential customers -- represent significant potential for immediate load reductions. Target customers are those with monthly consumption levels of at least 20,000 kWh, or maximum demand exceeding 100 kW.

The total population of target customers consists of approximately 400 accounts with an aggregate (non-coincident) billing demand of about 150 MW. Assuming that this load corresponds to 105 MW of coincident load,[2] the latter represents 18.5 percent of the national system peak load of 565 MW. This population can be further augmented by including any large customers, and water pumping loads served by the municipal utilities and cooperatives. This combined target population should consist of approximately 425 accounts with an aggregate demand of about 175 MW (non-coincident) or 122.5 MW (coincident) -- 22 percent of national peak load.

Potential Benefits of Load Management

A 1.0 kW reduction in customer peak demand would result in approximately 1.4 kW reduction in generation capacity, assuming a 30 percent dry year planning reserve margin, and 10 percent loss factor on-peak. This implies that a 1.0 kW reduction in peak load through a load management program could save $781.20 in generation capacity alone.[3] Using an annual capital recovery factor of 0.2, this translates into a savings of $156.24/kW-yr, or $13.02/kW-month. In addition, savings would accrue annually because of reduced fuel -- #2 (diesel) oil and furnace oil -- requirements

2 Ratio of coincident/non-coincident assumed to be 70 percent based on load analysis performed in Costa Rica and international experience.

3 The data in Appendix 1-4 indicate that the 1986 economic border price of a gas turbine was $558/kW.

during peak periods. Furthermore, savings in capital expenditures would accrue because of reduced -- delayed -- expenditures for transmission and distribution.

PROJECT APPROACH

Existing tariffs for residential, commercial, and small industrial customers do not contain direct incentives to cut loads during peak hours because they are not of the time-of-use or TOU type. The average price to a small C&I customer is around 3.5 colones/kWh or 5.2¢/kWh.

Incentives for larger customers to shave their peaks during peak hours are clearly transmitted in the coincident demand charge tariff offered as an option by ICE (Tariff-3), and by CNFL (Tariff-6). Under this tariff, the billing demand is assessed as the maximum recorded demand of the customer during the peak periods only. At present, these periods are defined by the two intervals: 10:00 a.m. to 12:30 p.m., and 4:30 p.m. to 8:00 p.m.

Unfortunately, the potential benefits of this tariff have not been realized. Since the tariff is optional, not all large accounts are on it, especially in the case of CNFL customers. Of the approximately 321 large CNFL accounts, only 43 were on the coincident demand Tariff-6 as of November 1987. Available data indicate that ICE has about 82 large accounts. Of these, 51 accounts are billed according to the Tariff-8. This leaves at total of more than 300 accounts not yet on TOU tariffs.

In addition, there is no mechanism in place to assist customers in managing their electricity demand profile to achieve savings without sacrificing product quality and output.

Another tariff designed to control peak demand is the interruptible Tariff-11 offered by ICE as an option.[4] Under this tariff, a customer must declare a firm service level (kW). This component of billing demand is charged according to whichever tariff is applicable, e.g., Tariff-2 or Tariff-3. Any interruptible demand -- i.e., demand in excess of the firm service level -- is billed at a substantially discounted price of $5.50/kW-month (compared with $11/kW-month for other tariffs).

4 CNFL does not now offer a comparable tariff.

Interruptible tariffs such as Tariff-11 and other forms of interruptible service are an extremely effective means of achieving peak shaving objectives. Unfortunately, the potential of this tariff is not being realized in Costa Rica. Although ICE offers such service, there are apparently no customers on it. CNFL and the other utilities do not even offer such a tariff.

Based on the preceding analysis and discussions held during the in-country visit, the study team recommends five steps to reduce peak demand:

1. Induce most "large" C&I customers to switch to the coincident demand charge tariff (ICE's Tariff-8, and CNFL's Tariff-6) by aggressive promotional and marketing programs.

2. Design, develop, and implement the necessary programs to help customers understand this tariff. Such programs must stress the partnership between the utility and its customer and demonstrate how both parties stand to benefit in a concrete financial sense.

3. Aggressively promote the interruptible tariff to all large customers.

4. Consider "fine tuning" the structure of the coincident demand charge tariff (Tariff-8 for ICE and Tariff-6 for CNFL). In particular, reducing the length of the evening peak period from 3 1/2 hours to 2 1/2 hours or even 2 hours appears highly desirable. A shorter peak period opens up more possibilities for load deferral. With a shorter peak period, higher peak charges -- capacity and energy -- can be charged as well. In this manner, the peak-to-off-peak price ratio can be increased, and a stronger incentive created for load reduction or shifting.

5. Do not dismiss the residential sector. Although coincident demands at the residential level may be small, there may be loads worth of consideration for load control and time-of-use applications. If properly marketed, and with the right incentives, it would not be unreasonable to obtain 100,000 residential participants in a TOU demand subscription rate. If a coincident demand reduction of 0.25 kW per participant where to be achieved, the load

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could be reduced by 25 MW, approximately 4 percent of the total system peak.

Because of the novelty of the concept in Costa Rica and because of the limited budget for this effort, a phased approach is recommended. Such an approach would entail a pilot project aimed at assisting users with large coincidental loads to reduce their demand during peak hours in two ways:

- On site control (by the user)
- Remote control (by ICE).

This combined approach is expected to offer the highest benefits in the short term.

The study team considered two types of systems for the project:

1) A radio-controlled load management system used to initiate control of a customer's loads. This system would only provide outbound (customer site) communications; it would not verify activation of control. A one-way system, although inexpensive in initial cost, would not provide some of the more desirable features of a two-way communications system.

2) A telephone-based load management system used to (1) initiate load control of a customer's loads and (2) monitor progress made in load control at selected sites (large users). This system would be able to provide two-way communication between the utility and the customer. It would also provide remote diagnostics of the load management equipment at the customer's site. Moreover, the same system would be able to provide a means of data acquisition for evaluating the reductions achieved at the facilities participating in the pilot project.

The second type of system was selected because:

- ICE is also the national telephone company
- ICE has already ordered equipment that would be suitable for such a system (computer, software, and electronic meters)

CANDIDATE SELECTION

From a list of large C&I customers and water pumping stations, the study team, together with ICE, selected a number of facilities for site visits. These visits typically lasted 2-4 hours and involved discussions with technical and management staff to identify (1) what loads could be controlled and (2) the degree of interest in participating in the project. Twenty-two facilities were visited to gauge more precisely the nature and extent of the potential, and to ascertain the types of issues and problems that would be encountered and must be addressed in designing and implementing a pilot project.

These initial target customers were visited jointly by representatives from RCG/Hagler, Bailly, Inc., FPL Qualtec, and ICE.

The 22 facilities can be broadly characterized as follows:

- Industrial Facilities. These facilities were found to contain large non-essential loads that are subject to interruption at the discretion of the facility or plant manager. Individual loads range from 10 HP to 500 HP in size. Total on-peak demand at these facilities generally ranges from 300 kW to 9,500 kW.

- Hotels. The three facilities analyzed ranged in size from 54 to 201 rooms. Total demand ranged from 40 kW to 470 kW.

- Other. (Hospitals, supermarkets, restaurants, and office buildings).

It became evident from these visits that significant load reductions could be obtained through load control. Since the maximum system peak occurs in the early evening, it is important to target those facilities where significant load reductions might be achieved during those hours. At 15 facilities with a total demand of 22.6 MW, 4.8 MW of potential controllable loads were identified (see Exhibit iii).

These 15 facilities were selected using a weighted ranking based on three criteria:

1) Presence of controllable load, and the controllable percentage of on-peak demand

Exhibit iii

Targets From Plants Visited

Plant Name	Peak Demand (kW)	Possible Reduction (kW)	Possible Reduction (%)	Approximate Cost to The Plant ($)
1. TICATEX	2,462	164	(6.7)	8,000
2. CONDUCEN	606	146	(24.1)	6,000
3. HOTEL CARIARI	399	50	(12.5)	3,000
4. COMPANIA NUMAR	960	100	(10.4)	6,000
5. CERVEZERIA COSTA RICA	1,500	50	(3.3)	8,000
6. FAB. NAC. LIQUORES	576	60	(10.4)	2,500
7. FERTICA	5,493	1,700	(30.9)	20,000
8. FAB. HIELO GUTIERREZ	182	15	(8.2)	2,000
9. EMPACADORA DE CARNES	1,316	375	(28.0)	10,000
10. HOTEL TAMARINDO	300 est	25	(8.3)	2,500
11. PRODUCTOS GERBER	318 [1]	230	(72.3)	--
12. EL GALLITO	806	150	(18.6)	2,000
13. BENEFICIO VICTORIA	704	50	(7.1)	3,000
14. RIGALIT	1,025	324	(31.6)	3,000
15. SCOTT PAPER	6,000	1,500	(25.0)	--
Total	22,647	4,789	(21.0)	73,500

[1] Needs to be confirmed.

Source: RCG/Hagler, Bailly, Inc. and FPL/Qualtec.

2) Customer willingness to participate

3) Cost effectiveness.

Because of the limited time spent in-country (about 2 weeks), the study team could not visit all possible candidates for the project. Therefore, ICE helped identify 20 additional candidates (which were not visited) to bring the total to 30-40. Assuming that 10 percent of the combined peak load of the 20 additional facilities could be cut (or about 1 MW), total peak reduction of the sample of 35 sites could reach 5.8 MW, or 17 percent of their total coincidental load (33.4 MW).

For this pilot project, the goal is not less than a 10 percent reduction, or not less than 3.5 MW for the sample of 35 sites.

IMPLEMENTATION

Although load management generally means a form of macro management of aggregate loads, the approach recommended for this pilot project is to limit the activities to load control of some individual customers that have a large potential for load reduction during peak hours. The project therefore represents the initial phase of a broader national load management program (which will be outlined at the end of this project).

The project will seek to enroll 30-40 customers with a large load reduction potential in a scheme where some controllable loads could be switched off following a signal sent from ICE to the customer. In some cases, customers may prefer to use their own system, e.g., an energy management system, to achieve the same result. If so, the equipment must be purchased by the customer, which will be charged directly in case of system or human failure. Where ICE is in total control, both the equipment cost and the responsibility will be borne by it, i.e., no charge will be levied if a pre-set load is exceeded at any given time.

Once the target group is finalized and the proposed load control strategies agreed on, then specifications for the load management system and data acquisition/analysis hardware and software should be developed to ensure that the system selected meets the "requirements" identified by ICE and the consultant.

The importance of obtaining load profile data at representative facilities as early as possible prior to finalization of the pilot project participants cannot be overemphasized.

Fortunately, ICE's quality control office has already ordered seventy SANGAMO electronic meters for use at its substations (to monitor peak demand) and by major customers, and a microcomputer to "manage" the load using ICE's telephone lines. The equipment should be in place and tested by late March. More than 40 meters are being installed at selected substations and large customer sites.

Cost/Benefit Analysis

The cost/benefit analysis for this project was conducted from three different perspectives:

- The user's
- ICE's
- The nation's.

User's Perspective: Based on data gathered during site visits, the average investment per kW peak saved is estimated at about $15 given existing tariffs (Tariff-8 of ICE and Tariff-6 of CNFL), which provide an incentive (a direct savings on the bill) of 727 colones or approximately $11 per month per kW saved. Depending on the user, the payback ranges from zero (manual stopping) to 12 months, which is very attractive; for an investment of $15 per kW peak saved, the payback would be less than 2 months.

ICE's Perspective: At peak time, each kW saved translates into avoided generation and transmission capacity at the margin. The value of this kW is estimated at $156 per year. The cost to ICE of implementing such a pilot project is estimated at less than U.S. $50,000[5] (it has already decided to purchase the electronic meters and the computer). Based on a 3.5 MW load reduction, the savings at ICE would be around $550,000 a payback of about 1 month.

5 Actually, there will be no specific cash outlay by ICE for this project as the equipment has already been purchased and because only existing labor will be used.

National Perspective: The national perspective is very close to that of ICE, because most of the cost of the new capacity is in foreign exchange, with almost no other costs (e.g. taxes or actual cost) to be borne by the government. In addition, the project will also save imported oil, because thermal equipment will be used less. The national interest will be the prime beneficiary of the project.

A load management project targeted at users with large coincidental peaks will be cost effective from a national and a private perspective as well as from ICE's perspective. If extended to the whole C&I population, such a project has the potential to reduce coincident peak by about 15 MW within one year. Technical risks are very low. The study team thus recommends that this project be implemented. A detailed implementation plan is outlined in Exhibit iv.

EXHIBIT IV

COSTA RICA LOAD MANAGEMENT PROJECT
Detailed Work Plan (1988)
(As of March 1988)

MONTH

	1	2	3	4	5	6	7 - 9	10	11
A. START UP									
ICE									
1. Organize initial workshop (opening seminar)	--0								
2. Finalize selection of target facilities		=====0							
3. Assign staff roles	=====0								
4. Finalize metering and monitoring procedures	=====0								
5. Install meters at selected sites		===0							
6. Install computer/test	-----0								
7. Develop sample output		.---===0							
PARTICIPATING INDUSTRIES									
1. Finalize arrangement/agreement		===0							
2. Identify/select control system	==========0								
3. Order equipment		==========0							
4. Set up internal organization		======0							
SUPPLIERS/CONSULTANTS									
1. Assist industries select equip/def specs		==========0---							
HBC/FPL									
1. Draft typical letter of agreement for indu.	==0								
2. Provide tech. assistance to participants		==========0---							
3. Train ICE/industry engineers/counterparts		==========0----							
4. Draft interim report				====0					
DSE									
1. Participate in initial workshop/meetings	=0			0			0		
B. DEMONSTRATION									
ICE									
1. Collect data/monitor progress at each site	==========0----								
2. Visit sites (at random)	*	*	*	*	*	*	*	*	
3. Track impact on peak load	==========0----								
PARTICIPATE INDUSTRIES									
1. Install equipment	==========0								
2. Implement load management project (gradually)	==========0----								
HBC/FPL									
1. Collect cost/benefit data and provide ad hoc T.A.		.----------==========0====							
C. DISSEMINATION									
ICE									
1. Fine tune cost/benefit data			---==========0						
2. Identify impact of demos over long term (seasons)							====0		
3. Estimate replicability (list of candidate facilities)						.========0			
4. Develop dissemination plan							=======0		
5. Prepare pamphlets and campaign for specialized magazines							---------=====---		
PARTICIPATING INDUSTRIES									
1. Prepare short report documenting experience							====0		
2. Allow site visits						----------			
3. Prepare programs for further steps							====0		
HBC/FPL									
1. Analyze load data							=====0		
2. Conduct detailed cost/benefit analysis						--------=======0			
3. Prepare overall conclusions and recommendations							====0		
4. Prepare final report							=======0		
CLOSING WORKSHOP (ICE & HBC/FPL)								*	

INTRODUCTION

In recent years, Costa Rica's Instituto Costarricense de Electricidad (ICE) has experienced a steady rise in evening peak demand, mainly because of domestic and rural demand for electricity for cooking and lighting. Original plans (as of 1987) to meet this growing demand had to be modified recently, as they were based on a projected growth in demand of 5.5 percent annually. In fact, recent statistics indicate that peak demand is rising much more quickly, at a rate close to 10 percent annually.

To meet this demand, ICE will have to install six 36 MW turbines before the year 2000, each costing $15 million in foreign exchange. This investment will hamper the government in its efforts to deal with the country's debt situation, as both the turbines and the fuel they use must be imported. Four such turbines are needed before 1992.

These turbines will play two roles: provide peak capacity and provide energy during the dry season. Their expected capacity utilization factor is around 45 percent or 4,000 hours/year for a dry year (20 years low). However, the first gas turbine is not going to be operational before 1989 and, until then, ICE will have to operate its thermal power units. However, of a total nameplate capacity of 140 MW, thermal units can only deliver at present between 20 MW and 70 MW mostly because of maintenance problems and lack of spare parts. Although representing 17 percent of total system installed nameplate capacity, these thermal units have produced less than 1 percent of the total energy generated in the country over the past 8 years. The existing hydrosystem, which represents 83 percent of total installed capacity, is currently constrained by the relatively low level of the Arenal dam, the major power regulating unit during the dry season. These bad dry season conditions are expected to last through 1989. Costa Rica is already importing about 50 MW of power from Honduras year round and cannot import more because the transmission line is used at full capacity.

Two viable options are being considered by ICE to minimize new generation and transmission investments: (1) encouraging large customers to generate their own power or purchase power from independent producers, or both, and (2) implementing a short-term load management/load control project to decrease some coincidental loads

occurring at peak hours. This study deals with the second option (the first is the subject of another, companion study titled: Non-Utility Power Generation in Costa Rica).

One immediate way of obtaining quick and sizable peak load reductions is to work with users to identify what portion of their peak load can be cut and help them to achieve these reductions. Time-of-use tariffs are already in place at ICE and CNFL, the major distribution company. These tariffs provide a strong incentive to medium and large commercial and industrial (C&I) users -- those with loads in the 50-10,000 kW range -- to reduce their demand during predefined "peak hours": 10:30 a.m. to 12:00 noon and 4:30 p.m. to 8:00 p.m. However, most C&I users have not taken advantage of these tariffs, for several reasons: they know little about the tariffs; they have little information on or experience with load control techniques and devices; and they are unaware of opportunities that may exist in their processes or operations for load reduction.

Only large, sophisticated energy users such as the national cement company have been able to achieve peak load reductions, and with impressive results. Industria Nacional de Cementos, for example, reduced its load from 9,000 kW (off-peak) to 3,000 kW (during peak), but such examples are exceptions (see Exhibits 1 and 2). The vast majority of users represent a large potential for peak load reduction at the national level. Realizing this potential requires a combination of:

- Information and awareness about time-of-use tariffs
- Technical assistance to identify options for direct load control
- Financial resources to purchase and install these load controls.

These needs were identified during a fact-finding visit conducted by RCG/Hagler, Bailly, Inc. under AID's Energy Conservation Services Program (ECSP) in the summer of 1986. This visit was requested by the Ministry of Natural Resources, Energy and Mines (MNREM) and the USAID mission of San Jose, Costa Rica.

Following this visit, a report and a subsequent proposal were prepared and submitted to MNREM and USAID. The proposal was officially approved the summer of 1987 and a first planning phase started in October 1987. This report presents the findings of

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INSTITUTO COSTARRICENSE DE ELECTRICIDAD

FAB. CEMENTO

THU 10/15/87

9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500

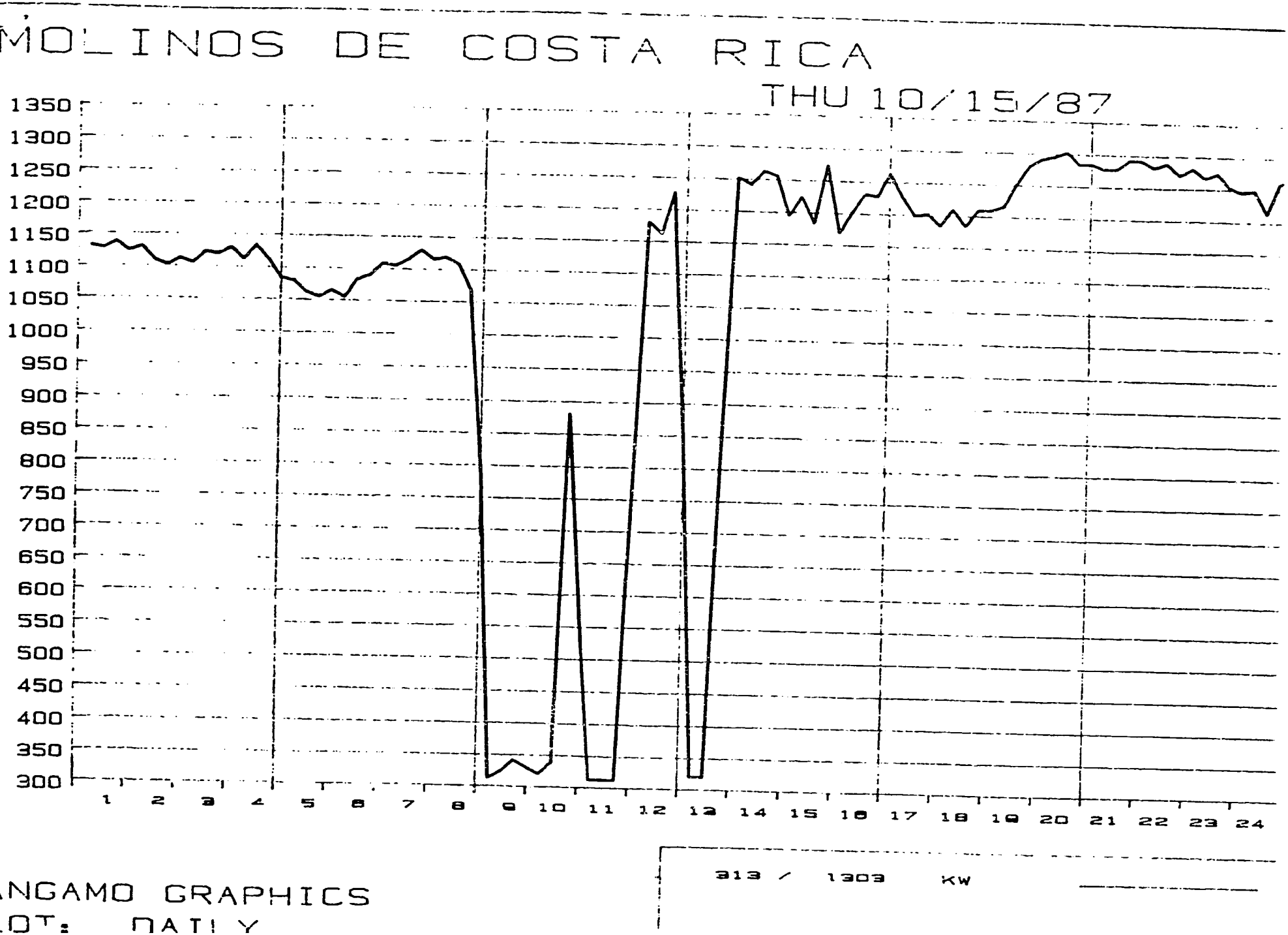
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

2838 / 8840 kW

SANGAMO GRAPHICS
PLOT: DAILY
RUN DATE: 11/24/87 07:29

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

Exhibit 2



24

the planning phase, together with an action plan for the implementation of the recommended activities.

Technical support to the RCG/Hagler, Bailly team was provided by FPL Qualtec, a subsidiary of Florida Power and Light.

In addition to this introduction, the report consists of three chapters. In Chapter 1, the background of the study -- Costa Rica's power situation -- is presented. In Chapter 2, options for direct load control are evaluated, and in Chapter 3, a detailed work plan for the implementation of a pilot project is described. The body of this report is supported by four appendices:

Appendix A: Load data

Appendix B: ICE's load characteristics

Appendix C: Load management equipment

Appendix D: ICE's selected load management system

CHAPTER 1: BACKGROUND

This chapter establishes the basic groundwork for the remainder of the report. The first section provides an overview of the major features of the electricity supply system in Costa Rica. The second section presents a review and analysis of customer load characteristics, and the third section identifies tariff-related strategies for load management that appear attractive for Costa Rica in the near- to mid-term.

ELECTRICITY SUPPLY SYSTEM

Costa Rica has 705 MW of installed hydroelectric capacity and 141 MW of installed thermal capacity for a total of 846 MW of capacity. (See Exhibits 1.1 and 1.2). This system is largely operated by the national electric utility, ICE (Instituto Costarricense de Electricidad).

ICE is a bulk supplier of electricity to several distribution companies, the largest of which is CNFL (Compania Nacional De Fuerza Y Luz), which serves the greater capital area of San Jose. The other distribution companies are either municipal entities or cooperatives. A map depicting the service areas of ICE and the distribution companies is provided in Appendix A.1.

Because of the predominant dependence on hydroelectric capacity, reliability planning for capacity additions is based on critical water conditions.[1] As a consequence, in most years the operating reserve margin is higher than the planning reserve margin to ensure that load can be met under dry conditions.

The typical mode of operation for the various generating plants is shown in Exhibit 1.3. The hydro stations at Menores, Garita, Rio Macho, and Cachi are essentially operated in a baseload mode together with power imports -- primarily from Honduras[2]. The seasonally regulated reservoir plants at Corobici and Arenal operate in an intermediate-base/cycling mode, while thermal plants meet peaking demand.

---

1 The dry year is defined as the year with the lowest recorded rainfall in a 20 year historical record.

2 Power imports began in 1977 as a means to reduce thermal generation.

Exhibit 1-1

Installed Hydroelectric Capacity in the Interconnected System[1] (November 1987)

Plant	Installed Capacity MW	Number of Units	Regulation Cycle	Capability: Dry Water Conditions GWh	Capability: Dry Water Conditions MW	Capability: Average Water Conditions GWh	Capability: Average Water Conditions MW
Arenal and Corabici	330	3 and 3	Hyper-annual	1,768	330	1,474	330
Cachi	100	3	Seasonal	468	80	685	90
LaGarita	30	2	Daily	156	26	190	30
Menores (CNFL)	29	19	Run-of River	171	16	193	23
Ventanas-Garita	96	--	Daily	345	90	516	96
Rio Macho	120	5	Daily	332	60	518	120
Total	**705**			**3,240**	**602**	**3,576**	**689**

1 Excluding ICE's very small hydro plants at Avance (.2 MW), Puerto Escondido (.2 MW), Los Lotes (.4 MW), and Cacao (.7 MW); and about 8 MW of small hydro capacity owned by other distribution companies.

Source: ICE

Exhibit 1-2

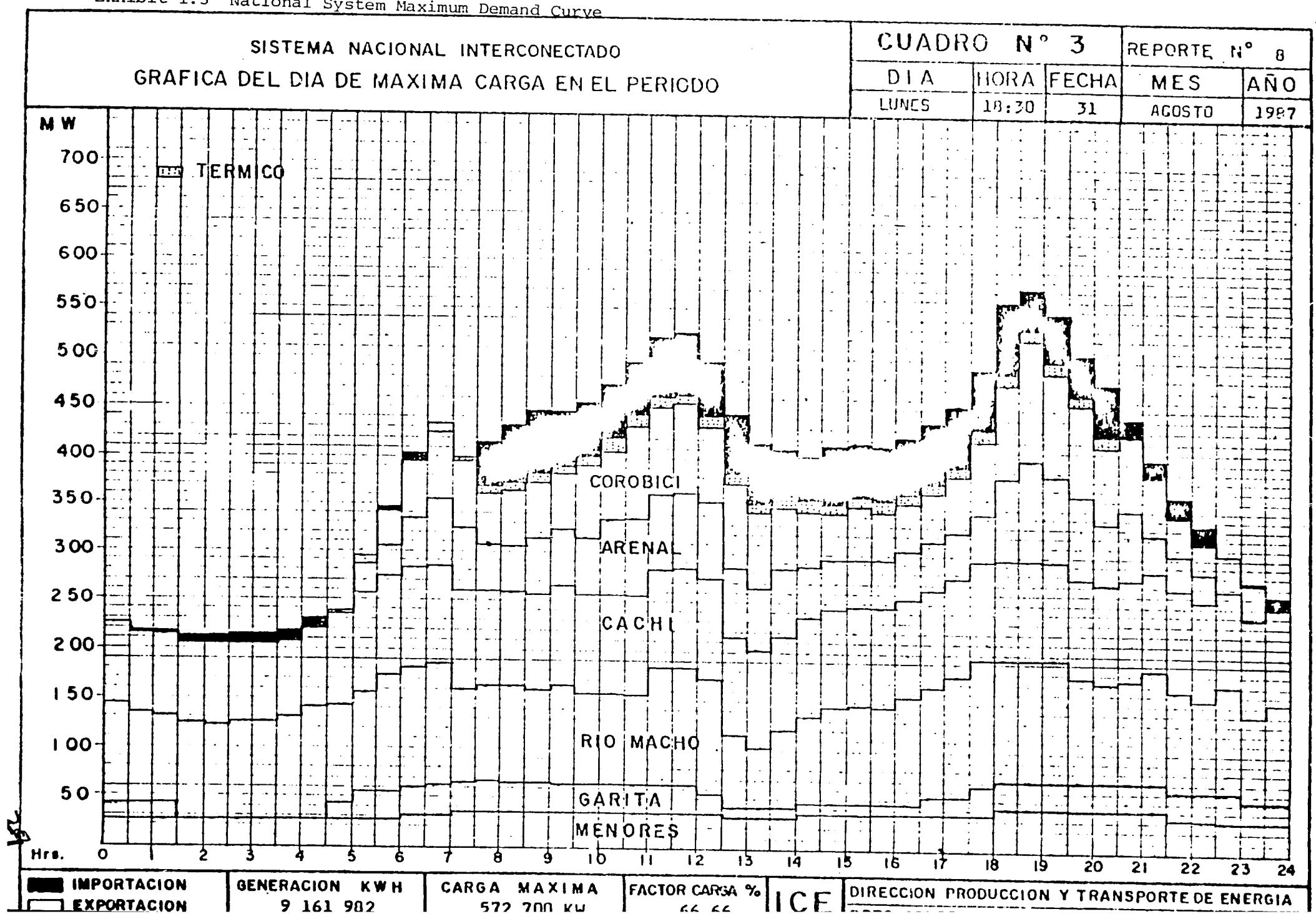
Installed Thermal Generating Plant Characteristics Owned By ICE (November 1987)

Station	Nameplate Rating (MW)	Number Of Units	Capability (MW)	Fuel	Heat Rate kWh/Litre	Daily Generation (MWh)
Colima (diesel)	19.5	6	17.0	#6	3.30	408
Moin (diesel)	32.0	4	26.0	#6	4.00	624
San Antonio (steam electric)	10.0	2	10.0	#6	2.25	240
San Antonio (gas turbines)	38.1	2	34.0	#2	2.50	816
Barranca (gas turbines)	41.6	2	35.0	#2	2.50	840
TOTAL	**141.21**	**122.0**	**122.0**			**2,928**

1 Excluding approximately 11 MW of diesels at Ciudad Neilly, Palmar Norte, Cahuita, and Horquetas in the interconnected system; and approximately 3 MW of small and isolated diesels at Upala, Los Chiles, Puerto Jimenez, Guatuso, Potrero Grande, Nosara, and Cobano.

Source: ICE

Exhibit 1.3 National System Maximum Demand Curve



Although Costa Rica was a net exporter of energy until 1985, since 1986 it has been a net importer.

Month	Exports (Imports) of Energy (GWh) 1982	1983	1984	1985	1986	1987
Jan.	0.0	22.0	66.3	16.8	0.0	(6.9)
Feb.	0.0	22.1	59.2	1.6	(2.2)	(5.9)
March	0.0	22.4	40.7	1.2	(11.3)	(2.3)
April	0.0	31.6	41.8	7.5	(12.1)	(6.6)
May	0.0	39.1	25.8	11.3	(6.7)	(8.5)
June	0.0	40.0	7.4	5.6	6.2	(17.4)
July	3.7	35.7	38.2	0.5	(3.5)	(22.3)
Aug.	13.9	47.9	42.2	5.2	(5.6)	(17.5)
Sept.	23.0	47.7	30.8	3.5	(23.4)	N.A.
Oct.	26.0	46.9	36.4	1.6	(14.2)	N.A.
Nov.	26.7	65.0	28.8	2.5	2.4	N.A.
Dec.	14.6	66.0	23.6	2.6	(7.0)	N.A.
Total	**107.9**	**487.4**	**441.2**	**59.9**	**(77.4)**	**N.A.**

N.A. = Not Available

Energy production by type of generation and by company is shown in Exhibit 1.4. In 1986, hydroelectric energy accounted for virtually all generation, and ICE was the largest producer of energy, representing over 92 percent of all power generated.

Exhibit 1.4

Energy Generation in 1986 by Company (GWh)

Company	Hydroelectric	Thermal	Total
ICE	2,641	6	2,647
CNFL	173	--	173
JASEC[3]	40	--	40
ESPH[4]	16	--	16
Coopelesca	15	--	15
Total Generation	**2,885**	**6**	**2,891**
Imports			77
Total Supply			**2,968**

3 Junta Administrativa de Los Servicios Electricos de Cartago.

4 Empresa de Servicios Publicos de Heredia.

In addition, 35 percent of ICE's total energy production in 1986 was supplied to consumers directly served by ICE (see Exhibit 1.5). This 954 GWh was split between large industrial consumers (410 GWh), residential users, primarily in rural areas (354 GWh), and public lighting and other general uses (190 GWh).

Of the 2,647 GWh produced by ICE, 59 percent -- 1,600 GWh -- was sold as bulk power for resale to seven major distribution companies. CNFL purchased over 80 percent of this amount (1,291 GWh).

The table below provides data on purchases, generation, final sales, and losses for each of the seven distribution companies.

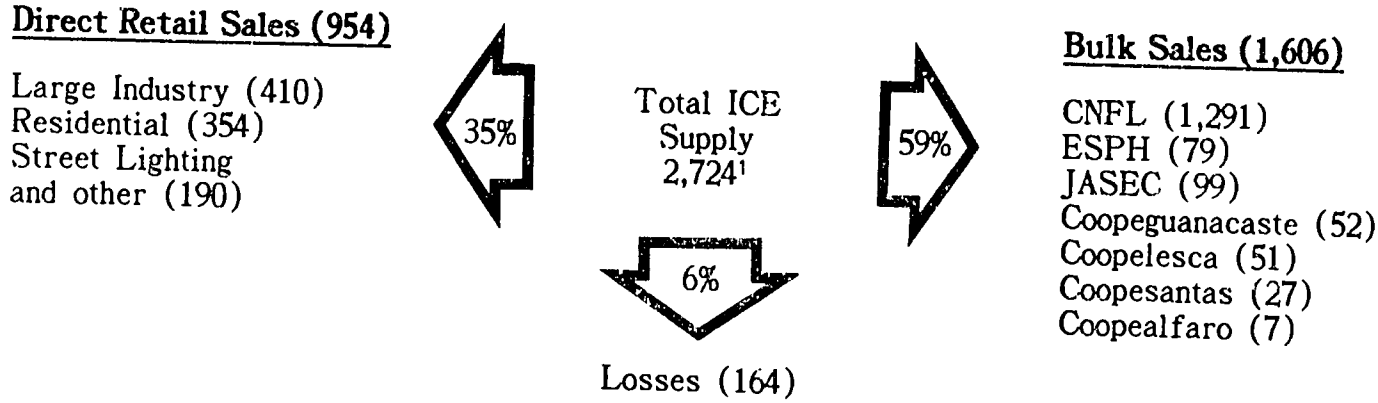
Distribution Company	Bulk Purchases (GWh)	Generation (GWh)	Sales (GWh)	Losses (%)
CNFL	1,291	173	1,400	4.4
ESPH	79	40	83	13.5
JASEC	99	16	123	11.1
Coopeguancaste	52	--	46	11.2
Coopesantos	26	-	24	10.2
Coopelesca	51	15	60	8.5
Coopealfaro	7	--	6	12.8
Total	**1,606**	**244**	**1,742**	**5.8**

No major changes have occurred in the consumption shares of various customer segments over the last 15 years. Consumption by the commercial sector and small industry sector has increased somewhat, at the expense of consumption by the residential sector.

	Customer Segment % Share of Sales					
Year	Commercial	Res.	Small Ind.	Large Ind.	Other	Total
1970	15.9	56.4	18.5	7.1	2.1	100.0
1975	20.7	49.2	18.1	9.5	2.5	100.0
1980	18.7	44.5	23.7	10.1	3.0	100.0
1986	22.5	46.0	20.5	7.9	3.0	100.0

Exhibit 1-5

Disposition of ICE Electrical Energy Supply in 1986 (GWh)



[1] Production of 2,647 GWh, plus imports of 77 GWh.

National electricity sales by major customer segment, system gross generation, and peak load for the 1970-1986 period are shown in Exhibit 1.6. In recent years, residential, commercial, and small industrial customer sales have grown by an average annual rate of 6-7 percent. In contrast, large industrial customer sales declined substantially in 1982 because of the economic downturn and have fluctuated considerably since then.

Since 1977, losses -- generation and network -- have fallen significantly. Starting from a high of about 15 percent, generation losses were down to around 9 percent in 1986, which compares very favorably with the best international performance.

Finally, the annual load factor has consistently been on the low side, in recent years stabilizing at around 59-60 percent.

Load Forecast and Expansion Plan

Under Costa Rica's medium-growth scenario, national electricity sales are projected to rise by an average 6.2 percent annually, from 2,671 GWh in 1986 to 8,384 GWh in 2005 (see Exhibit 1.7). Peak load at generation is expected to grow by 5.5 percent annually, from 565 MW in 1986 to 1,569 MW by 2005.

Average annual growth rates over the 1986-2005 period under three scenarios are given in the table below.

	Average Annual Growth Rate (1986-2005)	
Scenario	Gross Energy Generation GWh (%)	Peak MW (%)
Low	4.7	4.1
Medium	6.1	5.5
High	7.1	7.0

Under the medium scenario, the following average annual growth in sales, by sector, is projected: commercial, 8.0 percent; residential 4.6 percent; small industry 6.1 percent; large industry, 9.0 percent; and street lighting and public services, 2.0 percent. Detailed load forecast tables, by sector, for all three scenarios are provided in Appendix A.3.

Exhibit 1-6

Sales by Customer Class and Total Generation 1/

Year	Commercial		Residential		Small Industry		Large Industry		Street Lighting and Other		Total Sales		Generation		Losses %	Load Factor
	GWh	% Inc.	GWh	% Inc.	GWh	% Inc.	GWh	% Inc.	GWh	% Inc.	GWh	% Inc.	GWh	MW		
1970	128	--	454	--	149	--	57	--	17	--	805	--	942	202	14.54	0.532
1971	146	14.1	493	8.6	166	11.4	91	59.6	20	17.6	916	13.8	1,069	221	14.31	0.552
1972	169	15.8	535	8.5	185	11.4	107	17.6	23	15.0	1,019	11.2	1,184	242	13.94	0.559
1973	183	8.3	567	6.0	209	13.0	110	2.8	26	13.0	1,095	7.5	1,268	263	13.64	0.550
1974	210	14.8	601	6.0	237	13.4	108	-1.8	28	7.7	1,184	8.1	1,387	285	14.64	0.556
1975	258	22.9	613	2.0	225	-5.1	118	9.3	31	10.7	1,245	5.2	1,459	287	14.67	0.580
1976	290	12.4	638	4.1	251	11.6	125	5.9	35	12.9	1,339	7.6	1,576	304	15.04	0.592
1977	305	5.2	661	3.6	300	19.5	136	8.8	39	11.4	1,441	7.6	1,677	329	14.07	0.582
1978	300	-1.6	717	8.5	376	25.3	160	17.6	45	15.4	1,598	10.9	1,839	358	13.10	0.586
1979	320	6.7	747	4.2	403	7.2	168	5.0	50	11.1	1,688	5.6	1,910	378	11.62	0.577
1980	355	10.9	843	12.9	448	11.2	191	13.7	57	14.0	1,894	12.2	2,143	410	11.62	0.596
1981	437	23.1	901	6.9	417	-6.9	223	16.8	69	21.1	2,047	8.1	2,295	424	10.81	0.618
1982	508	16.2	946	5.0	383	-8.2	168	-24.7	74	7.2	2,079	1.6	2,292	446	9.29	0.589
1983	512	0.8	977	3.3	414	8.1	172	2.4	74	0.0	2,149	3.4	2,372	430	9.40	0.589
1984	532	3.9	1,046	7.1	480	15.9	200	16.3	79	6.8	2,337	0.7	2,568	483	9.00	0.606
1985	576	8.3	1,123	7.4	492	2.5	200	0.0	81	2.5	2,472	5.8	2,708	511	8.71	0.604
1986	609	5.7	1,242	10.6	552	12.0	212	6.0	82	1.2	2,697	9.1	2,968	565	9.13	0.600
Growth Rate 81-86		6.8%		6.6%		5.8%		-0.1%		2.3%		5.7%			5.90%	

1/ Includes ICE and all other companies, interconnected system plus isolated loads and imports.

Source: ICE

Exhibit 1-7

National Load Forecast
Medium Case

Year	Sales GWh	Sales % Growth	Generation (GWh)	Peak Load at Generation (MW)
1986 (actual)	2,671	-	2,968	565
1987	2,820	5.60	3,243	612
1988	2,974	5.44	3,272	615
1989	3,119	4.88	3,431	642
1990	3,266	4.70	3,592	668
1991	3,408	4.35	3,748	694
1992	3,572	4.83	3,929	723
1993	3,751	5.01	4,126	757
1994	3,955	5.44	4,350	795
1995	4,199	6.15	4,619	841
1996	4,472	6.50	4,919	893
1997	4,779	6.87	5,257	951
1998	5,115	7.04	5,627	1,013
1999	5,481	7.14	6,029	1,082
2000	5,876	7.22	6,464	1,157
2001	6,303	7.25	6,933	1,227
2002	6,763	7.31	7,440	1,303
2003	7,262	7.35	7,988	1,382
2004	7,800	7.41	8,580	1,473
2005	8,384	7.48	9,222	1,569
Average Annual Growth Rate (1986-2005)		6.2%	6.15%	5.5%

Source: ICE

Capital Expenditure Program

The high growth rate in electricity demand, even under the medium scenario, necessitates an ambitious expansion plan. The generation expansion plan for the medium scenario, shown in Exhibit 1.8, calls for additions of 220 MW of baseload geothermal capacity, 216 MW of gas turbine capacity for peaking, and 353 MW of hydroelectric capacity by the year 2000.

Exhibit 1.8

NATIONAL GENERATION EXPANSION PLAN
(As of March 1987)

Year	Plant Name	Capacity	Type
1990	Thermal	3x 36 MW	Gas turbines
1991	Thermal	36 MW	Gas turbine
1992	Miravalles-I	55 MW	Geothermal
1993	Sandillal	32 MW	Hydro
	Thermal	36 MW	Gas Turbine
1994	Miravalles - II	55 MW	Geothermal
	Toro I & II	24 + 66 MW	Hydro
1995	Thermal	36 MW	Gas Turbine
1996	Angostura	177 MW	Hydro
1997	Miravalles - III	55 MW	Geothermal
1998	-	-	-
1999	Siquirres	154 MW	Hydro
2000	Miravalles - IV	55 MW	Geothermal
Total 10 years		**889 MW**	

Source: ICE

Major technical, economic, and operating characteristics of all the projects in the expansion plan are provided in a table in Appendix A.4. Two charts depicting power and energy balances are shown in Appendix A.5 under the medium growth scenario and the corresponding expansion plan. Generation expansion sequences for the low and high scenarios are presented in Appendix A.6.

The capital expenditure plans -- generation as well as transmission and distribution -- corresponding to the generation expansion plans for the three growth scenarios are shown in Exhibit 1.9. Under the medium growth scenario, capital expenditures of about U.S.$1.7 billion will be required over the 1987-2005 period to meet projected load growth with adequate reliability. Of this amount, over 70 percent represents foreign exchange-related expenses.

Under the high growth scenario, investments of about U.S.$2.3 billion will be required. Even in the low growth case, about U.S.$1.2 billion is called for. Such investments represent a significant capital burden for the country, which already faces a very high external debt per capita ratio. It is therefore critical that every conceivable alternative to the traditional approach of supply enhancement be explored in an effort to meet the nation's growing electricity needs while reducing capital expenditure requirements.

This report focuses on the potential of demand/load management options for reducing peak load growth and thus realizing capital savings.

CUSTOMER LOAD CHARACTERISTICS

In this section, customer load shape characteristics are reviewed and assessed. This evaluation attempts to identify those major determinants of the system load curve that should be considered in designing a load/demand management program for Costa Rica.

The data on annual system load factors provided in Exhibit 1.6 indicate that there is considerable room for improvement. The reasons for the low load factor can be seen by examining the daily load curves for the power system. On a typical day (June 22, 1987), the load curve is marked by two peaks: the morning peak, which generally occurs between 10:00 a.m. and 12:30 p.m., and the evening peak, which occurs between 5:00 p.m. and 8:00 p.m. (see Exhibit 1.10).

The peak day load curve for 1986 is shown in Exhibit 1.11. Peak day load curves for years 1982 through 1985, provided in Appendix A.9 show that the dual daytime peak characteristics have remained unchanged as the system has grown larger. A review of

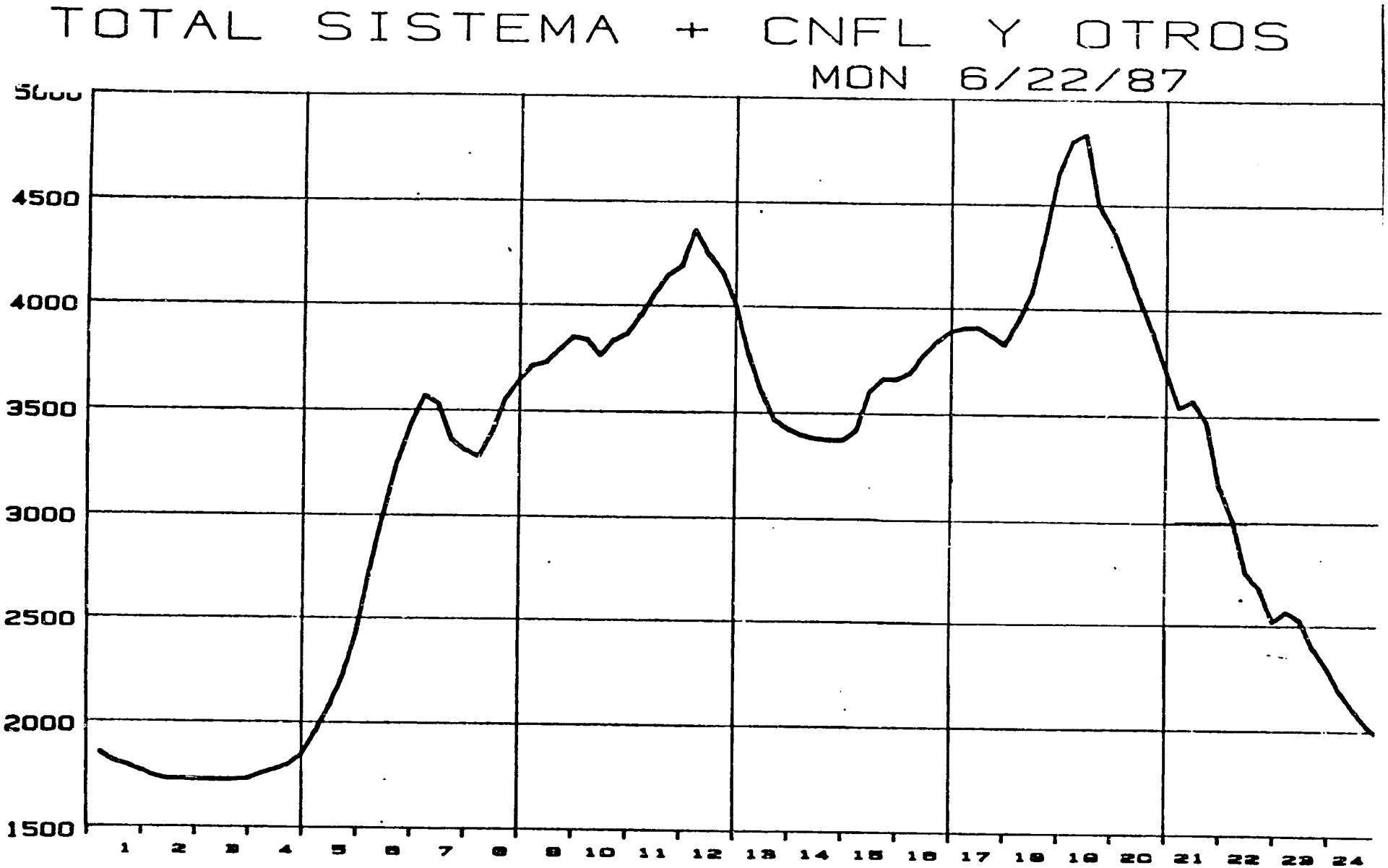
Exhibit 1-9

Capital Expenditure Plan
(million Dec. 1986 US $)

Project	Low Growth				Medium Growth				High Growth			
	# Units	Local	Foreign	Total	# Units	Local	Foreign	Total	# Units	Local	Foreign	Total
Hidroelectricos												
Sandillal	1	22.0	22.6	44.6	1	22.0	22.6	44.6	1	22.0	22.6	44.6
Angostura	1	89.0	157.7	246.7	1	89.0	157.7	246.7	1	89.0	157.7	246.6
Siquirres	1	103.9	129.3	233.2	1	103.9	129.3	233.2	1	103.9	129.3	233.2
Toro I	1	6.2	14.3	20.5	1	6.2	14.3	20.5	1	6.2	14.3	20.5
Toro II	1	13.2	18.9	32.1	1	13.2	18.9	32.1	1	13.2	18.9	32.1
Geotermoelectricos												
Geotermico I	1	32.9	74.0	106.9	1	32.9	74.0	106.9	1	32.9	74.0	106.9
Geotermico II	1	21.4	69.9	91.2	1	21.4	69.9	91.2	1	21.4	69.9	91.2
Geotermico III	1	21.4	69.9	91.2	1	21.4	69.9	91.2	1	21.4	69.9	91.2
Geotermico IV	1	21.4	69.9	91.2	1	21.4	69.9	91.2	1	21.4	69.9	91.2
Termoelectricos												
Gas 32	3	17.0	39.5	56.5	3	17.0	39.5	56.5		62.4	144.6	207.1
Carbon 60	0	0.0	0.0	0.0	1	5.7	76.4	82.1		11.4	152.7	164.1
Carbon 125	0	0.0	0.0	0.0	2	19.9	268.5	288.4		39.7	537.0	576.7
TOTAL GENERATION		348.4	665.7	1,014.1		373.9	1,010.6	1,384.5		444.8	1,460.6	1,905.5
Transmission and Distribution		69.7	133.1	202.8		74.8	202.1	276.9		89.0	292.1	381.1
TOTAL		418.1	798.9	1,216.9		448.7	1,212.7	1,661.4		533.8	1,752.8	2,286.8

Source: ICE

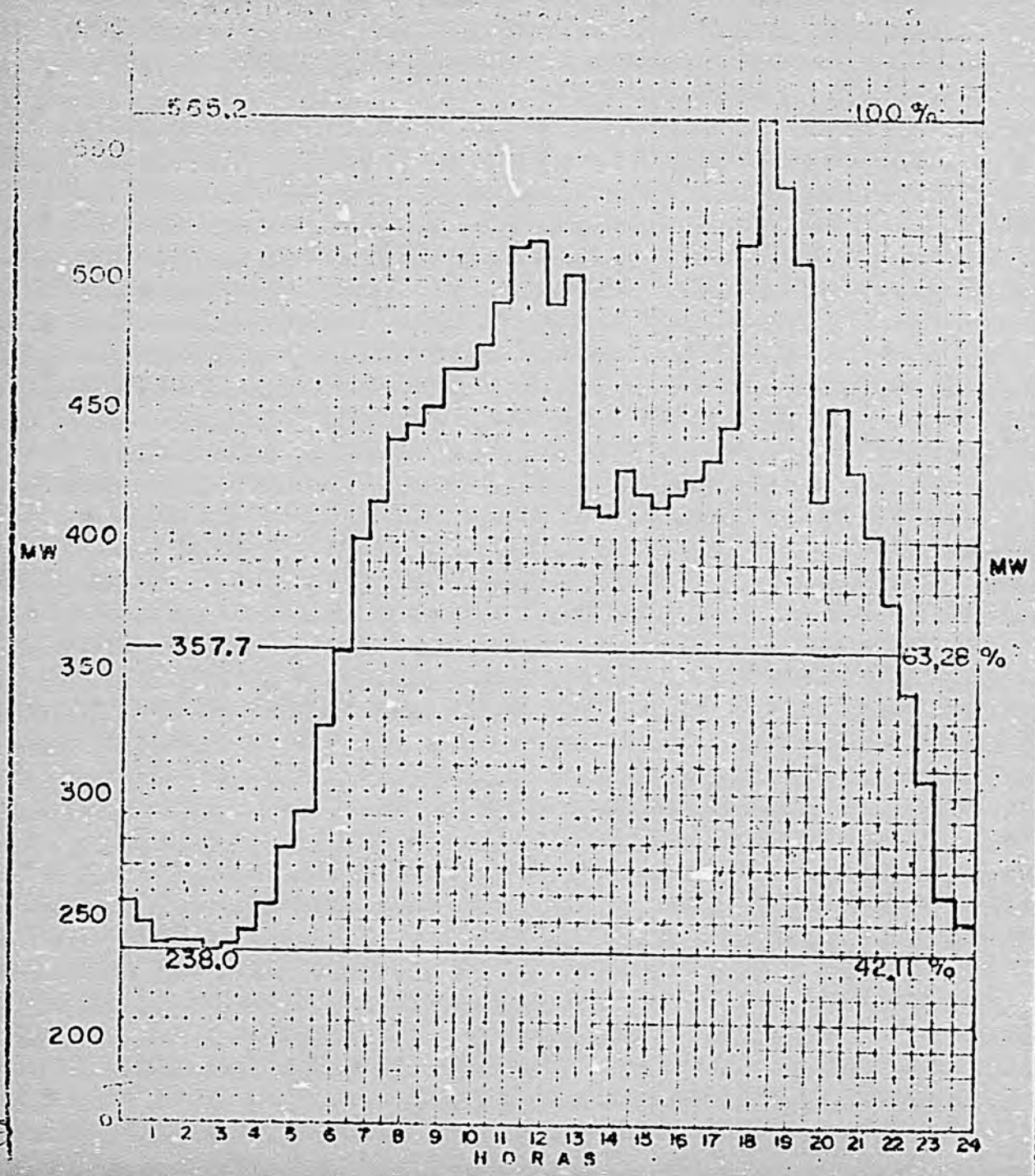
Exhibit 1-10



1721 / 4838 KW

SANGAMO GRAPHICS
PLOT: DAILY

Exhibit I.11 Maximum Load Curve



DIA	HORA	FECHA	MES	AÑO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EMPRESAS	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMIC				
TOTAL		[illegible]	565,2	[illegible]

EMPRESAS	GENERACION		FACTOR DE CARGA
	K W H	%	
MENORES			
CNFL-HIDRO			
ICE - HIDRO			
ICE -TERMIC.			
TOTAL	8 584 331	100.00	63,28

OBSERVACIONES: LA CURVA AQUI INDICADA CORRESPONDE A LA CARGA MAXIMA DEL PAIS.

I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA - OFICINA ESTADISTICA

MES : DICIEMBRE 1986

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z.	ARMANDO STAROSVIC B.	ING. ARMANDO BALMA

CUADRO Nº 4-A REPORTE Nº 12

typical weekday versus weekend load curves and of typical summer day versus typical winter day hourly loads (Appendix A.8) shows the same dual daytime peak.

The two peaks coincide with meal preparation times. An energy end-use survey conducted in 1983 found that nearly 43 percent of all households in the sample used an electric range for cooking, and an additional 5 percent of households used an electric hot plate.[5] Furthermore, the survey found that nearly 68 percent for all urban households used electricity for cooking, whereas the comparable percentage of rural households was only 23 percent.

Load research data gathered by ICE also confirms that the daily load curve for households with electrical cooking appliances is determined largely by the hourly loads for the cooking end-use. (Appendix 1.9).

Load research data on ICE's commercial and industrial (C&I) customers was also reviewed. Some typical curves are shown in Appendix A.10. These and other data that were examined suggest that, with the exception of some very large industrial loads that involve continuous processes, most of the C&I load can be characterized as a "9 to 5 one-shift load." This load typically increases around 8 a.m. at the start of the workday, remains fairly constant for the rest of the day, and then falls substantially at 5 p.m. in the evening.

Available evidence suggests that the primary contributors to the evening peak are the coincident household load (cooking, lighting, TV, appliances), street lighting, water pumping, high-load factor industries that work two or three shifts, and convenience retailing enterprises/shops that operate into the evening and early nighttime hours. With the exception of street lighting, most other loads contribute to the morning peak as well. In addition, the one-shift C&I segment -- office buildings, retail shops, small factories -- also contribute to the morning peak.

Unfortunately, no data exist to permit the hourly load curve to be broken down into its constituent customer components. For example, it is not possible to determine how the 1986 peak load of 565 MW (Exhibit 1.11) was split between the major load segments. This information gap can only be filled by analyzing load research data that have been

5 "Encuesta Residencial De Consumo Energetico", Direccion Sectorial De Energia (DSE), March 1985.

collected systematically from a statistically representative and sufficiently large sample of customers over a given period of time. ICE does have substantial amounts of load research data on individual customers, collected over different periods of time. However, this type of data does not provide the basis for developing a disaggregation of the system load curve.

Large C&I Accounts

Most of the load management/load control strategies recommended in this report focus on options aimed at the large C&I customers in Costa Rica because they appear to be the easiest targets. A coarse screen used to identify this target population in this report was the set of customer accounts with monthly consumption levels of at least 20,000 kWh or maximum demand exceeding 100 kW, or both. A list of ICE and CNFL customers, is provided in Appendix A-10 and A-11.

The data indicate that in this category there are 51 C&I accounts served by ICE with a combined billing demand (coincident with system peak) of about 49 MW. Furthermore, there are 24 accounts with aggregate (non-coincident) billing demands of about 16 MW. In addition, there are seven large water pumping accounts that together have a maximum (non-coincident) demand of about 6 MW. Without correcting for diversity, these 82 accounts represent about 71 MW of load. The fraction of this load suited for a load/demand management program can be determined by conducting audits of a sample of such accounts.

There are also 321 CNFL accounts that qualify as large C&I accounts. These accounts have a combined billing demand of 80 MW.

Thus, the target population of customers served by ICE and CNFL consists of approximately 400 accounts with an aggregate (non-coincident) billing demand of about 150 MW. This demand represents over 25 percent of the national system peak load of 565 MW. The target population of large C&I customers can be further augmented by including water pumping loads served by the municipal utilities and cooperatives. This combined target population should consist of approximately 425 accounts with an aggregate demand of about 175 MW (about 120-130 MW coincident load).

STRATEGIES FOR LOAD/DEMAND MANAGEMENT

This section of the report identifies and discusses strategies for load management that could play an effective role in restraining the rapid growth in peak demand for electricity. The section begins with a brief discussion of the load management concept, followed by a description of the broad range of options -- direct load control as well as tariff options -- that appear to hold promise for Costa Rica. Next, existing tariffs are evaluated from the perspective of furthering the desired load management goals, and finally, recommendations are made on tariff options for accomplishing these goals.

The Load Management Concept

Load management can be broadly defined as the deliberate control or influencing of customer electrical loads (levels and time-of-use pattern).

Broadly speaking, there are two classes of strategies for carrying out load management: direct load control and indirect load control.[6] Direct load control involves the physical on-and-off switching of end-use devices/loads by the utility. Indirect load control involves customer control of loads in response to price signals.

The simplest forms of direct load control entail the use of fuses, time switches, appliance interlocks, and other types of demand limiters that do not involve remote activation by the utility. In contrast, appliance cycling programs are activated and controlled by the utility. The most common of these involve the on-and-off cycling of residential water heaters and air conditioners and C&I central air conditioning systems during times of generation (or network) deficiencies. In terms of hardware, direct load control programs require a load controller on the customer premises that can switch the load on or off as required, and a communication system linking the utility dispatcher and the load controller.

The most common examples of indirect load control are:

- Demand charge tariffs where billing demand is measured coincident with system peak

6 A third strategy, energy storage, is not particularly relevant in the present context.

- Time-of-use (TOU) tariffs
- Super-off-peak rates
- Dynamic tariffs
  - dynamic interruptible tariffs
  - demand subscription service
  - real-time/spot-price-based tariffs.

Coincident demand metered tariffs and TOU tariffs require special metering equipment. However, no communication link is needed between the utility and the customer, as the rating periods and prices are specified well in advance. In contrast, most dynamic tariffs require metering with switchable registers that are activated remotely by a communication link, e.g., telephone, radio, power line carrier, ripple control system, telephone control system. Signals -- either price changes or a call for load reduction/interruption -- sent by the utility are received by a remote terminal unit located on customer premises. In the simplest implementation of dynamic tariffs, a human operator then takes the appropriate action. In automated installations, this signal is fed to an energy management system, which executes a pre-programmed sequence of actions. The most sophisticated instances involve a computer-to-computer real-time link between the utility and the load, with the customer's computer automatically executing demand limiting algorithms or process optimal reconfiguration and re-scheduling algorithms.

Objectives of Load Management

The ultimate goal of load management is to lower the average cost of electricity to those customers participating in the load management program (direct, immediate savings) as well as non-participants (indirect, future saving). To realize this goal, customer load shapes must be altered to bring about an improvement in load factors, a reduction in the need for peaking capacity, and higher utilization or more efficient baseload generation.

A critical first step in developing any load management program is to clearly establish and define the program's objectives. Five common objectives of load/demand management are summarized in Exhibit 1.12.

Given Costa Rica's customer and system characteristics, a major load management goal is peak shaving. Peak shaving (or clipping) consists of reducing customer loads (MWs) during system peak conditions. In Costa Rica, the focus would be on reducing peak loads during the two peak periods: mid-morning and evening. Clipping these loads would increase the efficiency of power production by (a) reducing new peaking capacity requirements (generation and network), and (b) reducing the consumption of expensive fuel (Number 2 oil) in peaking units.

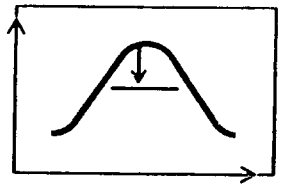
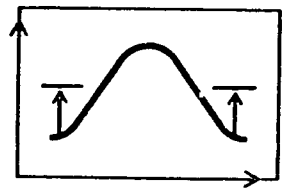
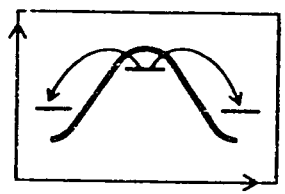
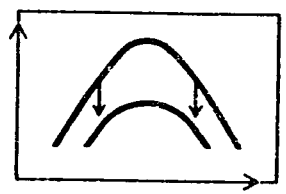
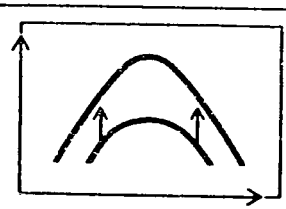
A secondary, albeit important, goal is valley filling. This effort consists of stimulating sales of non-firm (surplus/secondary) hydroelectric energy during wet conditions/seasons.

Target Customer Segments

Six types of customer segments are responsible for the bulk of the peak load:

- Residential customers
  - cooking
  - hot water
- Large office buildings
  - air conditioning/ventilation
  - lighting
- Hotels
  - air conditioning/ventilation
  - lighting
- Large industry
- Water pumping

DEMAND MANAGEMENT CAN HAVE MANY DIMENSIONS

		Residential	Commercial	Industrial
Peaking clipping, or reduction of load during peak periods, is generally achieved by directly controlling customers' appliances. This direct control can be used to reduce capacity requirements, operating costs, and dependence on critical fuels.		• Accept direct control of air conditioners	• Accept direct control of water heaters	• Subscribe to interruptible rates
Valley filling, or building load during off-peak periods, is particularly desirable when the long-run incremental cost is less than the average price of electricity. Adding properly priced off-peak load under those circumstances can decrease the average price.		• Use off-peak water heating	• Store hot water to augment space heating	• Add nighttime operations
Load shifting, which accomplishes many of the goals of both peak clipping and valley filling, involves shifting load from on-peak to off-peak periods, allowing the most efficient use of capacity.		• Subscribe to time-of-use rates	• Install cool-storage equipment	• Shift operations from daytime to nighttime
Strategic conservation involves a reduction in sales, often including a change in the pattern of use. The utility planner must consider what conservation actions would occur naturally and then evaluate the cost-effectiveness of utility programs intended to accelerate or stimulate conservation actions.		• Supplement home insulation	• Reduce lighting use	• Install more-efficient processes
Strategic load growth, a targeted increase in sales, may involve increased market share of loads that are or can be served by competing fuels, as well as development of new markets. In the future, load growth will include greater electrification—electric vehicles, automation, and industrial process heating.		• Switch from gas to electric water heating	• Install heat pumps	• Convert from gas to electric process heating

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- Street lighting.

Reducing the electrical cooking load through a load management program -- direct load control, pricing, or even energy storage -- is unlikely to prove effective. Meal times are dictated by the daily pattern of work and of leisure habits. Most households are unlikely to change this pattern significantly. The most effective way to shave the cooking-related peak may be by encouraging a switch from cooking with electricity to cooking with liquefied propane gas (LPG). A careful assessment is needed to determine whether a combination of pricing incentives for LPG and tax rebates/incentives to promote the purchase of gas ranges would be in the country's long-term interest.

According to the residential energy use survey cited earlier, approximately 20,000 tank hot-water units were in place in 1983. More data need to be collected to estimate the number, type, and capacity (gallons, and rating of the heating resistor element) of these units, and to ascertain some of the demographic and socioeconomic characteristics of the households that own such units. Without this information, it will be difficult to determine whether a load management program involving the cycling of water heaters merits further investigation. At this stage, all that can be said is that such a program may not hold much promise, as the hot water heating loads may be largely non-coincident with the system peaks. However, load research that sheds light on this issue would be worthwhile.

To achieve positive results in the near- to mid-term, it is likely to be more advantageous to target large customers with high demands (kW) and low load factors. If the benefits of load management can be convincingly demonstrated to them, these customers are more likely than residential customers to opt for such programs, and thus more likely to reduce their electricity bills. Furthermore, the costs of marketing load management programs to this segment may be lower, as only a few hundred customers are involved.

Potential Benefits of Load Management

The argument in favor of load management in Costa Rica is rooted in the high cost of generating capacity needed to meet projected electricity demand growth. Generating capacity can be reduced by 1.4 kW for every 1.0 kW reduction in customer peak

demand, assuming a 30-percent dry year planning reserve margin and a 10-percent loss factor on-peak. Thus, a 1.0 kW reduction in peak load achieved through a load management program can save $781.20 in generation capacity.[7] Using an annual capital recovery factor of 0.2, this savings translates into a savings of $156.24/kW-yr, or $13.02/kW-month. In addition, savings will accrue annually because fuel requirements will be reduced during peak periods. And capital expenditures will be reduced because transmission and distribution expenditures are either reduced or delayed.

Indirect Load Control (Tariff) Options for Load Management

This section presents an assessment of the most commonly used tariffs in Costa Rica. The effectiveness of these tariffs in promoting desired load management objectives is examined, and recommendations are made on tariff options/revisions aimed at realizing these objectives.

ICE's residential tariff (TI) is a base energy tariff with an increasing block structure:[8]

Block	Price
First 30 kWh/mo. (Minimum charge)	83.0¢
Next 20 kWh	2.78¢/kWh
Next 50 kWh	3.00¢/kWh
Next 150 kWh	3.38¢/kWh
Next 150 kWh	4.51¢/kWh
Next 400 kWh	6.77¢/kWh
Remaining kWh	9.02¢/kWh

CNFL's residential tariff has a similar structure, but fewer blocks. Such pure energy tariffs without time-of-use (TOU) variation in unit energy costs do not provide any price incentives for consumers to reduce their peak loads or shift energy use to off-peak periods. Furthermore, based on U.S. experience, TOU metering is unlikely to be cost-effective for all but the largest domestic users. Thus, gains in economic efficiency will not outweigh the incremental costs of TOU metering and billing.

7 The data in Appendix 1-4 indicate that the 1986 economic border price of a gas turbine was $558/kW

8 An exchange rate of 66.5 colones was used.

A review of bill frequency analysis (BFA) tables revealed 899 ICE residential accounts and 3,776 CNFL accounts with monthly consumption exceeding 2,000 kwh. The large ICE accounts represented 4.6 percent of total residential sales, and the large CNFL households accounted for 12.4 percent of residential sales.[9] The possibility of placing such large accounts on a TOU tariff or demand subscription service merits further study.

Small commercial and industrial customers (i.e., those with monthly consumption not exceeding 3,000 kWh) are charged a flat energy tariff:

	Energy Charge	
	Small Commercial $/kW	Industrial $/kW
ICE	9.26	8.02
CNFL	8.05	7.49

Since these customers are on a non-time differentiated tariff, there is no financial incentive for them to peak shave.

Medium-sized C&I customers (those with monthly consumption between 3,001 and 20,000 kWh) and large C&I customers (those with monthly consumption exceeding 20,000 kWh) are charged according to a two-part demand and energy charge tariff. The variable energy charge structure is constant in all instances, as shown below:

	Variable Energy Charge (U.S.¢/kWh)			
	3,001-20,000 kWh/mo.		Greater than 20,000 kWh/mo.	
Utility	Comm.	Ind.	Comm.	Ind.
ICE	5.50	4.72	4.03	3.43
CNFL	4.53	3.97	3.73	3.19

9 July '87 BFA for ICE, and June '86 BFA for CNFL.

The variable portion of the demand charge structure for these customer segments is:

	Demand Charge ($/kW-month)			
	3,001-20,000 kWh/mo.		Greater than 20,000 kWh/mo.	
Utility	Comm.	Ind.	Comm.	Ind.
ICE	8.50	7.28	8.50	7.28
CNFL[10]	6.94	6.43	6.94[11]	6.43[12]
	-	-	11.57	9.77

Billing demand for C&I customers is based on a simple meter that indicates maximum monthly demand. These meters are reset each month. Demand charge tariffs do provide incentives to customers to manage their individual peak loads. However, they do not provide any incentive for customers to reduce kW demand during periods of system peaks, unless the customers' demand happens to reach a maximum during system peak times.

Incentives for customers to peak shave are clearly transmitted in the coincident demand charge tariff offered as an option by ICE (Tariff-8), and by CNFL (Tariff-6). Under these tariffs, billing demand is the customer's maximum recorded demand during peak periods only. At present, there are two such periods: 10:00 a.m. to 12:30 p.m., and 4:30 p.m. to 8:00 p.m.

These tariffs (ICE's T-8 and CNFL's T6) also have seasonal features. Demand charges are assessed at zero on Saturdays, Sundays, and holidays, during the rainy season (June through January). In addition, there is a substantial incentive to shift energy consumption to the wet season from the dry season (February through May). This incentive is structured as follows. First, the difference between the average monthly consumption during the wet season and the dry season is calculated. The energy charge for any "excess" consumption during the rainy season is 1.61¢/kWh. The remaining

10 CNFL rates are lower than ICE because they own some old, fully amortized hydro power plants which lower their weighted average cost.

11 Lower charge is for each kW billing demand between 28 kW and 87 kW. Higher charge applies for each kW exceeding 87 kW.

12 Lower charge applies to each kW billing demand between 28 kW and 67 kW. Higher charge applies to each kW billing demand exceeding 67 kW.

energy is billed according to the higher energy charges that are applicable under tariffs T-2 and T-3, as the case may be.

The demand charge structure and billing determinants under T-8 (for ICE) and T-6 (for CNFL) provide an effective and available mechanism for conveying the right price signals to C&I customers. Unfortunately, the potential benefits from these tariffs have not been realized. As these tariffs are optional, not all large accounts (presently in T-2 and T-3) are being billed under them. Available data indicate that ICE has about 82 large accounts.[13] Of these, 75 are billed according to the T-8 tariff. CNFL has approximately 321 large accounts, of which at most 5 are on the T-6 tariff.

In addition, the potential benefits of the T-8 and T-6 tariffs are not being realized because there are no mechanisms in place to help customers manage their electricity demand profile.

A review of load curves for several large customers served by ICE indicates that with two exception customers on the T-8 tariff have not reduced their coincident demand substantially. The primary reason for this lack of response appears to be that most of these customers need assistance in figuring out how to make such load reductions without compromising plant operations. This was borne out during the course of our plant visits that are discussed in subsequent chapters. A common initial reaction during the plant visits was that there were no significant loads that were controllable at that facility. However, by the end of the visit, this feeling had reversed in a large number of instances.

ICE also offers an interruptible T-11 tariff as an option.[14] Under this tariff, a customer must declare a firm service level (kW). This component of billing demand is charged according to whichever tariff is applicable, e.g., T-2, T-3. Any demand in excess of the firm service level -- the interruptible demand -- is billed at a substantially discounted price of $5.50/kW-month. ICE can offer this discount because, during capacity deficiencies, it can call on these customers to reduce their load down to the firm service level. It thus does not have to plan and build generation capacity to serve the non-firm load. The customer's risk is limited to certain provisions or conditions of

13 See Appendix 1-10.

14 CNFL does not yet offer a comparable tariff.

interruptibility. Under T-11, interruption frequency is limited to a maximum of two per day, not to exceed a total interruption time of 2 hours/day, and 300 hours/year. This tariff contract can be terminated with a 2-year notice.

Interruptible tariffs such as T-11 and other forms of interruptible service are an extremely effective means of achieving peak shaving. Unfortunately, the potential of this tariff is not being realized in Costa Rica. Although ICE offers such service, there are apparently no customers using it. CNFL and the other utilities do not offer such a tariff option.

Finally, ICE offers an optional T-16 tariff. This tariff is similar to T-8 in that is has coincident demand charges. However, T-16 has a more complicated energy charge time-of-use structure. Energy costs under T-16 vary by time-of-day as well as by wet and dry season. A comparable tariff is not offered by the other utilities. In addition, no ICE customer is on T-16, perhaps because, while it has many desirable features, it is overly complicated for most customers to grasp to respond to. It is useful to have such a tariff in place for promotion sometime in the future. But for the near- and mid-term, the T-8 and T-11 tariffs provide a more effective avenue for achieving peak shaving.

Based on the preceding analysis and discussion, several tariff-related recommendations are offered to promote peak load reduction:

1. Switch all "large" C&I customers to the coincident demand charge tariff (ICE's T-8 tariff, and CNFL's T-6 tariff) through the use of promotional and marketing programs. This should also be done for large customers served by other utilities.

   For this purpose, a "large" customer can be defined using one or more criteria in combination, e.g., maximum demand at least equal to 100 kW and monthly consumption of at least 20,000 kWh.

2. Design, develop, and implement the necessary programs to help customers understand this tariff. These programs should also help customers to reduce their coincident demand in ways that are best suited to their specific needs and situation. Simply enrolling customers into this tariff will not in itself provide any significant load reduction on-peak. The utility companies will

need to offer information programs, provide technical assistance and design support, conduct training, and even assist in hardware and software procurement where necessary. Such programs must stress the partnership between the utility and its customer and demonstrate how both parties stand to benefit in a concrete financial sense.

3. Aggressively promote the interruptible tariff to all large customers. In ICE's case this is Tariff-11. Other utilities should develop and promote such a tariff as well. Again, promotion involves much more than enrollment. Initially, the utilities will have to provide substantial assistance in helping customers decide on and implement optimal response strategies.

4. Consider "fine tuning" the structure of the coincident demand charge tariff (T-8 for ICE and T-6 for CNFL). In particular, the desirability of reducing the length of the evening peak period from 3 1/2 hours to 2 1/2 hours or even 2 hours should be analyzed. A shorter peak period opens up more possibilities for load deferral. With a shorter peak period, higher peak charges -- capacity and energy -- can be levied as well. In this manner, the peak-to-off-peak price ratio can be increased, and a stronger incentive created for load reduction or shifting, or both.

5. Consider developing dynamic tariff options similar in concept to the Peak Day Withdrawal (PDW) option of Electricite de France (EDF), and the non-firm dynamic energy rate based on short-run marginal cost that is being promoted in Sweden to large users with dual-fired boilers.

   Under the PDW option, EDF reserves the right to declare up to 22 days in the year as "peak" days. On such days, the energy cost is six to ten times the normal price. Such a load control rate option can be effectively employed in Costa Rica for C&I as well as residential customers. Load data reveal that national demand in Costa Rica in recent years has exceeded 95 percent of the peak load for that year for a total duration of 20 hours to 40 hours a year. Therefore, load control under a PDW type rate would most likely be exercised 5 to 10 days a month for only a few months of the year. In addition, the duration of each incident would probably not exceed 2 hours.

In the Swedish example, the utilities have financed the installation of electric boilers where oil/gas boilers already exist. This makes it possible for customers to quickly switch their boiler fuel, depending on the prevailing spot prices for competing fuels. In particular, under favorable water conditions, the price of non-firm electrical energy is extremely low, and such customers can take advantage of the price.

In Costa Rica, this kind of tariff would enhance the nation's energy conservation objectives and increase overall economic efficiency in the energy sector by facilitating optimal fuel substitution in the short run as well as the long run. In particular, since power system expansion is based upon dry water conditions, in most years the amount of hydropower available would exceed energy demand. This secondary energy can be usefully employed to reduce oil consumption in industrial boilers.

6. Consider load management in the residential sector. Although coincident demands at the residential level may be small, some loads may be worth considering for load control and time-of-use applications. If properly marketed, and with the right incentives, it would not be unreasonable to obtain 100,000 residential participants in a TOU rate , demand subscription rate, or PDW type rate. If each participant could reduce coincident demand by 0.25 kW, a load reduction of 25 MW could be achieved. Such a reduction represents approximately 4 percent of the total system peak.

CHAPTER 2: OPTIONS FOR DIRECT LOAD CONTROL

In this chapter various direct load control options are first presented. Second, we describe in greater detail the technologies and approaches recommended for Costa Rica. Third, the selection of target sites for the pilot project is presented together with some important recommendations for the project implementation from a technical standpoint. Finally, a preliminary cost/benefit analysis is conducted.

TECHNOLOGICAL OPTIONS FOR LOAD CONTROL

A wide variety of load control technologies are available for load management applications. Two types of control systems are addressed in this chapter: remote load control systems and local load control systems.

For a load management system to be effective, the utility must have total control of the customer loads that are to be reduced; therefore, in this case remote control systems are needed. They are normally activated on an as-needed basis when the utility needs to reduce loads to meet the demands on its system, or based on other criteria to be determined by the utility.

Technical Characteristics of Control Systems

All load management systems consist of four basic sub-systems:

- Central controller
- Signal transmitter or injection device
- Communication link
- Signal-receiver terminal units.

The central controller is the heart of the system. It initiates a series of commands to shed or restore the loads, and receives the inputs on the system status and meter readings. It is connected to various peripherals for data processing, signal generation,

encoding/decoding, and monitoring. The signal transmitter or injection device impresses the control signal on the communications link.

The communications link carries the signal to the signal-receiver terminal unit, which -- if appropriate -- acts on commands to open or close a switch controlling the customer's load, reads the meter, or transmits requested data to the central controller.

The signal-receiver terminal unit consists of an interface to the communications link, a receiver/transmitter, an encode/decoder, control relays, meter readings apparatus, and a logic unit to interpret the commands and initiate action.

Four basic media are used for transmission of the signal, and all load management systems use some variation or combination of them:

- Radio - These systems use FM transmitters to transmit control signals to radio receiver switches at the point of control. Widely used and with predictable performance, the cost per control point tends to be less than for other communication and control systems.
  - FM-VH
  - AM broadcast
  - FM broadcast (FM-SCA)
- Power Lines

  Ripple control - These systems transmit low frequency signals using the utility transmission and distribution network as a medium. The impulses are received by ripple control receivers at the point of control.

  Power line carrier - These systems transmit high frequency signals using the utility's transmission and distribution network as a medium. For bi-directional communications, transponders are used at the point of control, adding monitoring capabilities. The economics of such a system become more favorable with applications involving large numbers of control points.

Power Frequency Carrier (sine wave alteration).

- Telephone - Having load control capabilities similar to the power line carrier system, this system uses a telephone interface to achieve load control using a central computer at the utility.

- Cable TV (CATV).

The various types of communications systems and how they transmit the signal to the customer site are shown in Exhibit 2.1.

Local control systems are normally used by customers and some utilities to control the customer's loads. The major disadvantage of these systems is that the utility does not have control of them and thus cannot activate them at its own discretion. Some examples of local control systems are:

- Interlock (priority relay) - Current-sensing devices that prevent the simultaneous operation of two or more high loads.

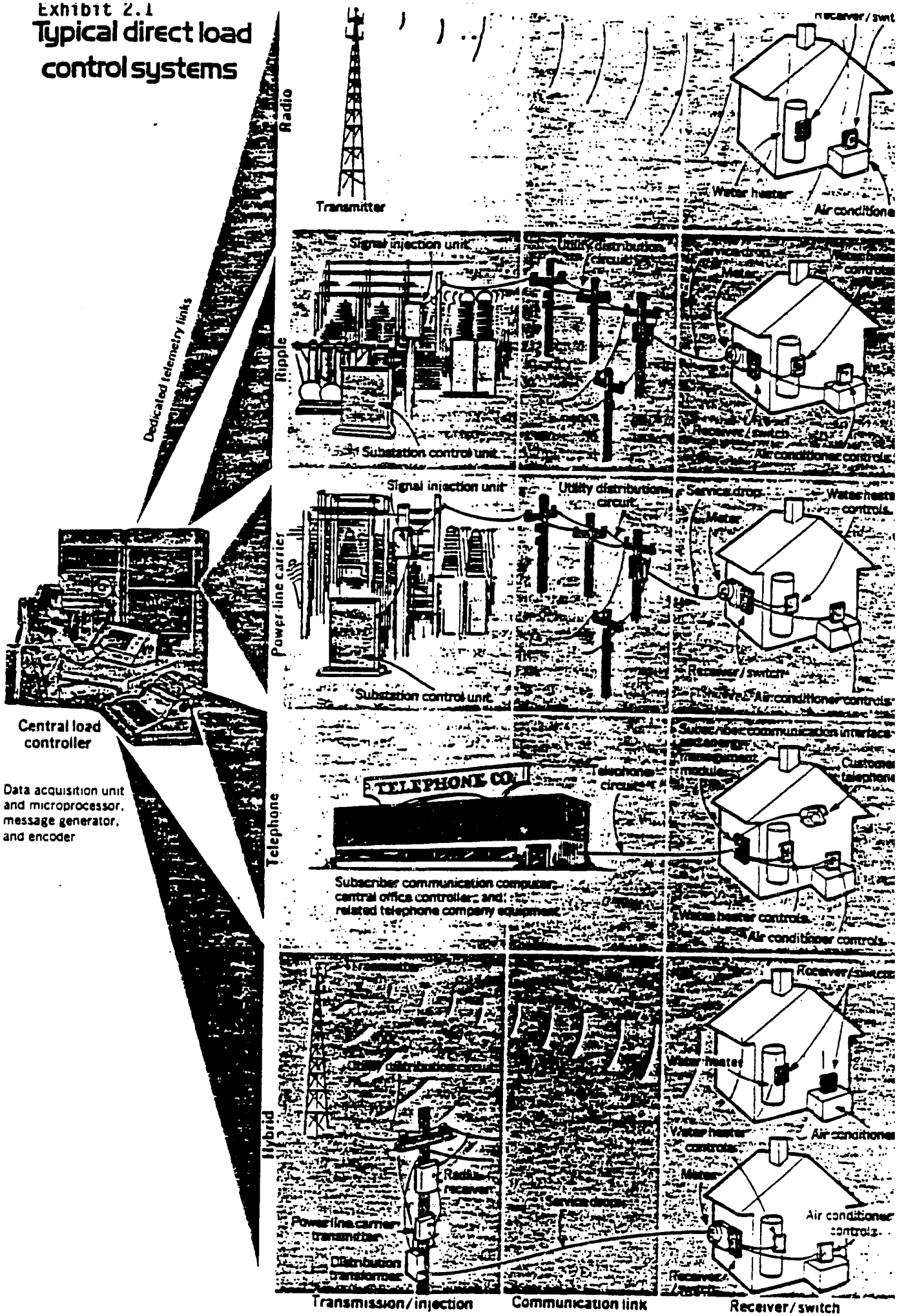
- Time controllers - Electronic devices used to turn off or duty cycle loads such as compressors, HVAC, pumps, motors, refrigeration systems, and lighting at pre-determined times.

- Demand limiters - These range in size from small microprocessors to larger computer-controlled energy management systems (EMSs) and can be used to limit demand by deferring or duty cycling loads in a preprogrammed manner.

- Energy management systems (EMSs) - These systems are microprocessor-based and are used to provide a variety of control functions for loads in a facility. These functions include: time-of-day scheduling, demand control, duty cycling of equipment, priority scheduling, and automatic temperature setback/set-up. Because of the wide diversity of EMS product offerings, an in-depth study is needed to determine the compatibility of the system with the needs of the facility. A partial listing of EMS manufacturers is provided in Appendix "B".

Exhibit 2.1

Typical direct load control systems



Interfacing a load management system with a customer's EMS allows the utility to activate load control by using the customer's installed control systems, relays, and monitors, thus observing the load priorities selected by the customer. The key is that the EMS must have a lower demand level that would be activated upon initiation of a contact closure or other means to ensure reduction or deactivation of the customer's loads.

RECOMMENDED LOAD CONTROL TECHNOLOGIES AND TECHNIQUES

Load Control Technologies between Utility and Customer

Based on the requirements constraints and objectives of this project, and preliminary information on the data analysis software and the equipment available for data gathering, one of two actions is recommended:

1) Select a radio controlled load management system as a means of communication to initiate customer load control. This system would only provide outbound (customer site) communications and not verification of activation of control. However, a one-way system, although inexpensive in initial cost, does not provide some of the more desirable features of a two-way communications system.

2) Select a telephone-based load management system as a means of communication to initiate customer load control. This system would be able to provide two-way communication between the utility and the customer, and would also provide remote diagnostics of the load management equipment at the customer's site.

   Another advantage of this system is that it would also be able to provide a means of acquiring data to use in evaluating the reductions achieved at the facilities participating in the load control pilot project.

Because ICE is also the National Telephone Company and because they have already ordered suitable equipment, the second approach has been retained.

Once the target group is better defined and proposed load control strategies are agreed on, a specification will be developed for the load management system and the data acquisition/analysis. Hardware and software can then be selected to ensure that the system selected meets the "requirements" of the project as identified by ICE and the consultant. Whereas the computer and the meters have already been ordered by ICE the software has still to be defined.

Important considerations (specifications) to keep in mind in the selection of the system includes:

- Existing operation and maintenance practices and problems
- Condition of existing mechanical/electrical equipment and its compatibility with load control technology
- Detailed list of mechanical/electrical equipment and associated controls
- Operating schedules of building and equipment
- Understanding of utility rates
- Major energy use areas
- Number and types of loads to be controlled
- Types of functions required
- In-house capabilities
- Method(s) of controlling loads
- Possible changes in the future
- Load management training requirements
- Load management maintenance requirements
- Vendor reliability.

Load Control Equipment at Customer Site

The strategy for controlling customer loads depends on the type of equipment to be controlled, the size of the load to be controlled, and the sensitivity of the load to the customer's operation. For example, some loads may have to be brought down in sequence in a manufacturing facility, whereas other non-essential loads may be shed and restored by the utility without affecting the customer's operations.

Various types of loads, and methods of controlling them are outlined below:

1) Commercial/Industrial Loads - In commercial/industrial facilities the most attractive option may be to interface the load control system with the customer's EMS. Thus, when load control is activated, a predetermined but lower set point is established for the EMS system to maintain. This lower set point would be verified by the data gathered in the load survey monitoring equipment.

2) Air Conditioning or Space Heating Loads - These loads can usually be cycled without causing any inconvenience to the customers. In some cases, the customer may be willing to accept shedding of these loads for a higher load control credit.

3) Refrigeration Loads - Owing to the unavailability of air conditioning loads in many of the facilities visited, there may be a need to investigate the potential for cycling or shedding some of the larger refrigeration loads such as walk-in freezers. In these cases, care should be taken to provide temperature override capabilities to prevent the temperature from increasing beyond a pre-determined set point. However, the accessibility of the control circuits may need to be investigated to determine the potential for control. Similar loads such as ice makers could possibly be cycled or shed for short periods.

4) Electric Water Heaters - These loads can usually be shed for a few hours without causing significant inconvenience to customers.

Other controllable loads may include:

- Swimming Pool Pumps
- Lighting Controls, and
- Occupancy Sensors.

POTENTIAL CANDIDATES FOR PILOT LOAD MANAGEMENT PROGRAM

The target population of "large" C&I customers and water pumping loads that appear promising from the point of view of eventually implementing a nationwide load management was first identified.

Plants Visited

Upon completing this analysis a number of facilities were selected with ICE for site visits. These visits typically lasted 2-4 hours and involved discussions with technical and management staff in order to identify (1) what loads could be controlled and (2) the degree of interest in participating in the project. Site visits to 22 facilities were conducted. This was done in order to gauge more precisely the nature and extent of the potential, as well as ascertain first hand the types of issues and problems that will be encountered and must be addressed in designing and implementing a pilot project.

These initial target customers were visited jointly by representatives from both Hagler, Bailly, and ICE. (See Appendix C for summary of visits).

The 22 facilities that we visited can be broadly characterized as follows.

1. Industrial Facilities: These facilities were found to contain large non-essential loads that are subject to interruption at the discretion of the facility or plant manager. Individual loads range from 10 to 500 HP in size. Total on-peak demand at these facilities generally range from 300 to 9,500 kW in demand.

2. Hotels: The three facilities analyzed ranged in size from 54 to 201 rooms. Total demand ranged from 40 to 470 kW.

3. Other (hospitals, supermarkets, restaurants and office buildings).

It became evident from these visits that significant load reductions may be obtained through load control (see Exhibit 2.2). Since the maximum system peak occurs in the early evening, it is important to target those facilities where significant load reductions may be achieved during those hours. Specifically, 4.8 MW of potential controllable loads were identified at 15 of the facilities which have a total demand of 22.6 MW (see Exhibit 2.3).

These 15 facilities were chosen using a weighted ranking, based on the following three criteria:

1) presence of controllable load, also the controllable percentage of the on-peak demand

2) customer willingness to participate

3) cost effectiveness.

As shown in Exhibit 2.4, most facilities visited have a high weighted average (greater than 25) that indicates a high suitability for the project.

Other candidates. Because of the limited time spent in country (about 2 weeks), it was not possible to visit all possible candidates for the project. Therefore, to arrive at a sample of 30-40 candidates (see proposal), assistance from ICE was provided to identify on paper other potential participants. As a result, 20 additional customers were identified (see Exhibit 2.5). Assuming that 10 percent of the combined peak load of the 20 additional facilities could be cut (or about 1 MW), total peak reduction of the sample of 35 sites could reach 5.8 MW or 17 percent of total load (33.4 MW).

Target load reduction = 10 percent of peak load of the sample or about 3.5 MW.

EXHIBIT 2.2: CHARACTERISTICS OF VISITED FACILITIES

PLANT NAME	LOG'N	UTIL.	MW DEMAND CHARACTERISTICS (1987) MAX ON-PEAK	MAX OFF-PEAK	AVER.	GWH ENERGY CONSUMP. 1986	THRU OCT. 1987	POSSIBLE PEAK REDUCTION (MW) MIN.	MAX.	CONTROL SYSTEM TYPE	LOW COST, $	HIGH COST, $
TICATEX	S.J.	ICE	2.462	2.462	2.337	13.390	11.599	0.164	0.270	EMS	7,000	9,000
CONDUCEN	S.J.	ICE	0.606	0.606	0.494	1.898	1.400	0.146	0.180	EMS	5,000	7,000
HOTAL CARIARI	S.J.	CNFL		0.399		1.641	1.302	0.050	0.100	DC/SHED	2,000	4,000
INDUSTRIA NACIONAL DE CEMENTO	CARTAGO	ICE	3.945	9.446	7.727	41.492	38.642	-	Already have microcomputer-based system			
COMPANIA NUMAR	S.J.	CNFL	0.960	0.965	0.924 *	6.286	5.305	0.100	0.210	EMS (?)	5,000	7,000
HOSPITAL MEXICO	S.J.	CNFL		0.816		4.345	3.364	-	-			
CERVECERIA COSTA RICA	ALAJUELA	CNFL	1.500	1.682	1.400	8.548	7.349	0.500	0.100	Study needed		
FABRICA NACIONAL DE LIQUORES	GRECIA	ICE	0.576	0.576	0.475	1.756	1.934	0.060	0.075	EMS	2,000	3,000
CAFETALERA PILAS (ORCAFE)	NARANJO	ICE	0.397	0.397	0.195	0.683	0.537	-	Have system already in place			
EL ANGEL	CINCHONA	ICE	0.078	1.258	1.149	0.992	1.905	-		EMS		
FERTICA	PUNTARENAS	ICE	5.493	5.823	4.830	32.552	22.869	1.700	1.800	EMS		
FABRICA DE HIELO GUTIERREZ	PUNTARENAS	ICE	0.182	0.184	0.178	1.292	1.106	0.015	0.090			
EMPACADORA DE CARNES (EL ARREO)	HEREDIA	CNFL	1.316	1.316	1.125 *	5.453	4.246	0.375	0.500	Microcomputer based system		
HOTEL TAMARINDO	TAMARINDO	COOP/GUANACASTE				0.992		0.025		DC/SHED	2,000	3,000
MOLINOS DE COSTA RICA	S.J.	ICE	-	1.674	1.612	7.670	7.000	-				
HOTEL AUROLA	S.J.	CNFL		0.470		1.920	1.934	-		DC/SHED	2,000	4,000
PRODUCTOS GERBER	S.J.	CNFL	0.318	0.525	0.184 *	2.080	2.068	0.230	0.580			
EL GALLITO IND.	S.J.	CNFL	0.806	0.806	0.746 *	2.960	2.515	0.150		EMS	1,500	2,500
BENEFICIO VICTORIA	GRECIA	ICE	0.704	0.711	0.271	1.035	0.985	0.505	0.100	EMS	2,000	4,000
RIGALIT	CARTAGO	ICE	-	1.025	0.835	3.336	3.604	0.324	0.349	EMS	2,000	4,000
LAMINADORA COSTARRICENSE	S.J.	CNFL	2.086	2.100	0.697 *	4.676	5.344	N/A	N/A/	EMS	6,000	8,000
MILLER HMNOS.	S.J.	CNFL							0.200	EMS		
SCOTT PAPER	SAN ANTONIO	CNFL	4.760	4.690	4.725	N/A	N/A	1.500	2.100	Study needed (peak hours must be reduced to allow this reduction)		

* 0.580 after expansion.

SOURCE: RCG/HAGLER, BAILLY, INC.

Exhibit 2.3

Targets Selected From Ranked Facilities

Plant Name	Peak Demand (kW)	Possible Reduction (kW)	Possible Reduction (%)	Approximate Cost to The Plant ($)
TICATEX	2,462	164	(6.7)	8,000
CONDUCEN	606	146	(24.1)	6,000
HOTEL CARIARI	399	50	(12.5)	3,000
COMPANIA NUMAR	960	100	(10.4)	6,000
CERVECERIA COSTA RICA	1,500	50	(3.3)	8,000
FAB. NAC. LIQUORES	576	60	(10.4)	2,500
FERTICA	5,493	1,700	(30.9)	20,000
FAB. HIELO GUTIERREZ	182	15	(8.2)	2,000
EMPACADORA DE CARNES	1,316	375	(28.0)	10,000
HOTEL TAMARINDO	300 est	25	(8.3)	2,500
PRODUCTOS GERBER	318*	23	(72.3)	--
EL GALLITO	806	150	(18.6)	2,000
BENEFICIO VICTORIA	704	50	(7.1)	3,000
RIGALIT	1,025	324	(31.6)	3,000
SCOTT PAPER	6,000	1,500	(25.0)	--
Total	22,647	4,789	(21.0)	73,500

*Needs to be confirmed

Source: RCG/Hagler, Bailly, Inc.

EXHIBIT 2.4

FACILITY RANKING FOR PILOT PARTICIPATION

Name of Facility	(A) CONTROLLABLE LOAD Rank* (1-5)	x Weight	= Subtotal 5	(B) WILLINGESS TO PARTIC. Rank* (1-5)	x Weight	= Subtotal 3	(C) COST EFFECTIVENESS Rank* (1-5)	x Weight	= Subtotal 2	Total
TICATEX	5	X	5 = 25	3	X	3 = 9	3	X	2 = 6	40
CONDUCEN	5	X	5 = 25	5	X	3 = 15	3	X	2 = 6	46
HOTEL CARIARI	3	X	5 = 15	5	X	3 = 15	2	X	2 = 4	34
INDUSTRIA NACIONAL DE CEMENTO			5			3			2	
COMPANI[illegible] [illegible]UMAR	5	X	5 = 25	4	X	3 = 12	2	X	2 = 4	41
HOSPIT[illegible] [illegible]EXICO	*			*		3			2	*
CERVECERIA COSTA RICA	2	X	5 = 10	3	X	3 = 9	2	X	2 = 4	23
FABRICA NACIONAL DE LIQUORES	3	X	5 = 15	2	X	3 = 6	3	X	2 = 6	27
CAFETALERA PILAS (ORCAFE)	1	X	5 = 5	3	X	3 = 9	-		2	N/A
EL ANGEL	1	X	5 = 5	5	X	3 = 15	-		2	N/A
FERTICA	5	X	5 = 25	5	X	3 = 15	4	X	2 = 8	48
FABRICA DE HIELO	2	X	5 = 10	2	X	3 = 6	1	X	2 = 2	18
GUTIERREZ										
EMPACADORA DE CARNES (EL ARREO)	5	X	5 = 25	5	X	3 = 15	4	X	2 = 8	48
HOTEL TAMARINDO	5	X	5 = 25	3	X	3 = 9	1	X	2 = 2	36
MOLINOS DE COSTA RICA	0	X	5 = 0	0	X	3 = 0			2	
HOTEL AUROLA	2	X	5 = 10	4	X	3 = 12	4	X	2 = 8	30
PRODUCTOS GERBER	5	X	5 = 25	5	X	3 = 15	4	X	2 = 8	48
EL GALLITO IND.	5	X	5 = 25	5	X	3 = 15	4	X	2 = 8	48
BENEFICIO VICTORIA	3	X	5 = 15	5	X	3 = 15	2	X	2 = 4	34
RIGALIT	5	X	5 = 25	5	X	3 = 15	5	X	2 = 10	50
LAMINADORA COSTARRICENSE	* 2	X	5 = 10	3	X	3 = 9	N/A		N/A	N/A
MILLER HMNOS.	* 3	X	5 = 15	4	X	3 = 12	N/A		N/A	N/A
SCOTT PAPER	5	X	5 = 25	4	X	3 = 12	5	X	2 = 10	47

* Further investigation necessary.

N/A = Not applicable

See next page for explanation and key to ranking.

Source: RCG/Hagler, Bailly, Inc.

Exhibit 2.4 (continued)

Explanation of Criteria and Weights Used in Exhibit 2.4

A. **Controllable Load**

Definition: Portion of the maximum load that can be cut during peak hours

Weight = 5. This is the single largest criterion because it is a quantifiable measure of what can be accomplished by the project.

Rank : 1 if controllable load represents less than 5% of tota' demand

2 if controllable load represents between 5% and 10% of total demand

3 if controllable load represents betweem 10% and 15% of total demand

4 if controllable load represents betweem 15% and 20% of total demand

5 if controllable load represents more than 20% of total demand

B. **Willingness to Participate**

Definition: Indication of facility management interest in the project and their willingness to participate

Weight = 3. Second most important criterion for the project as it represents a key factor for project success.

Rank: 1 if company shows no/little interest

2 if company shows little interest

3 if company showed some degree of interest

4 if company was interested

5 if company was very interested and agreed verbally to participate

C. Cost Effectiveness

Definition: Measure of financial return to the user and to ICE

Weight = 2. Because, although cost effectiveness is always important in any project, most technology applications identified during the in-country visit were very cost effective

Rank: 1 if pay back is more than 6 months

2 if pay back is between 3 and 6 months

3 if pay back is between 2 and 3 months

4 if pay back is between 1 and 2 months

5 if pay back is less than 1 month

Exhibit 2.5

List of Potential Additional Candidates

	Plant Name	Activity	KW	kWh/Month
1.	CEMPA	Cement	415.00	155,000
2.	Hacienda La Luis S.A.	Sugar	398.00	270,000
3.	Avicola La Garita	Food	206.61	101,184
4.	Cartago Beef Packing	Meat Packing	855.00	410,000
5.	Cia. Minera Esperanza S.A.	Minerals	316.89	129,499
6.	Ingenio Taboga S.A.	Sugar	1,200.00	270,000
7.	Consejo Nal. Produccion	Slaughterhouse	640.08	241,692
8.	Beneficio El General S.A.	Coffee Processing	450.84	217,464
9.	Cia. Bananera de C.R.	Veg. Oil	402.69	159,916
10.	Cia. Bananera de C.R.	Veg. Oil	335.00	97,000
11.	Ricalit S.A.	Fabrica	740.00	295,400
12.	Envaco Med. # 1	Fab. Boxes	325.00	110,000
13.	Florencia Cofee Co	Sugar	530.04	194,890
14.	Hacienda Atirro Ltda.	Coffee Processing	250.00	55,000
15.	Hacienda Atirro Ltda.	Sugar	200.00	45,000
16.	Talmana S.A.	Seafood Packing	264.38	126,316
17.	Azucarera El Palmar S.A.	Sugar	1,062.25	701,750
18.	Empacad. Carne C.R.S.A.	Meat Packing	1,038.24	430,500
19.	Crown Cork S.A.	Cork	545.76	157,364
20.	C.N.P. Montecillos	Slaughter House	640.08	241,692
		Total (rounded)	**10,817**	**4,410,000**

Source: ICE

Implementation Considerations

Once the target group is finally defined and proposed load control strategies agreed upon, then specifications for the load management system and data acquisition/analysis hardware and software should be developed to ensure that the system selected meets the "requirements" identified by ICE and the consultant.

The importance of obtaining load profile data at representative facilities as early on as possible prior to finalization of the pilot program participants cannot be overemphasized.

Very fortunately for the project, ICE's quality control office has already ordered a specialized computer and more than one hundred SANGAMO electronic meters for use at its substations (to monitor peak demand) and major customers as well as a microcomputer to "manage" the load, using ICE's telephone lines (see Appendix D). The equipment should be in place and tested by January. Already more than 40 meters are being installed at ICE's substations and/or 5 large customer sites.

During of the facility visits, most managers said access to load profile data was a priority. Without hourly kW demand data, it is difficult for facility engineers to identify periods of load control opportunities and develop the operational strategies needed to reduce on-peak demand. In cases where only a thermal demand meter is available -- as in the Hotel Aurola -- either a magnetic tape meter or the new Sangamo electronic "Data Star" recorder should be installed to generate the needed load profiles. Once the data gathering capability is available on-site, average or "typical day" and "peak day" kW demand hourly profiles should be made available on a monthly basis by the utility to the engineers at participating facilities. These profiles should also be saved on a monthly basis for each of the pilot project sites.

Those customers contemplating the installation of an EMS might want the utility to provide an electronic pulse through the electronic recorder system. Some EMSs provide their own demand monitoring capability through the use of current transformers. In such cases, the utility load control system should be interfaced with customer EMSs to facilitate the implementation of the pilot project. Load profiles

should be made available to pilot project participants on a monthly basis to optimize their ability to program their EMSs for maximum load reductions.

Based on the overall needs of the project and the short-term implementation schedule, an "off-the-shelf" telephone-based system using electronic data recorders is recommended for communicating with customers.

If electronic recorders cannot be delivered or installed within the project's schedule, then interrogation of these units should be performed manually or through the use of magnetic tape meters.1

All these steps can be taken by ICE once the computer and the meters become operational.

PRELIMINARY COST/BENEFIT ANALYSIS

The cost/benefit analysis of a load/demand management program was conducted from three different perspectives:

- The perspective of the user
- The perspective of ICE
- The national perspective.

User's Perspective: As shown in the previous section, the average investment per kW peak saved is about $15, that is a payback of less than 2 months, because ICE provides an incentive (immediate bill reduction) of 737 colones or approximately $11 per month. Even if this amount is doubled to take into account staff time spent on the project, the average payback would still be around 2 months. In the worst case, e.g. CERVECERIA COSTA RICA and Hotels, this specific investment is less than $160 per peak kW saved for a pay back of 15 months. Projects with paybacks of less than 18 months are considered attractive by management standards.

1 Note: This recommendation assumes that the failure rate of magnetic tape recorders and/or loss of data are not significant.

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ICE's Perspective: At peak time, each kW saved translates into avoided capacity at the margin. Because ICE is considering installing peaking gas turbines at $508/kW, one could consider that the annualized value of the new power is a valid proxy for estimating the value of the kW saved through local management. This value would be roughly $111 or close to the T-8 tariff. If transmission costs are taken into consideration, this value is about $156/kW. The cost to ICE if implementing such a pilot project is estimated at less than US $50,000 (because they have access to the telephone lines and because they have already decided to purchase the electronic meters and the computer). Based on a 3.5 MW load reduction, the savings at ICE would be around $550,000 for a payback of about one month.

National Perspective: In this case, the national perspective is very close to that of ICE, because most of the cost of the new capacity is in foreign exchange and because there are almost no other costs (e.g. taxes or actual costs) to be borne by the government. In addition, less oil would have to be imported for thermal power plants (peak hours). The national interest will be the prime beneficiary of the project.

Conclusions

A load management program targeted at users with large coincidental peaks will be very cost effective from a national and a private perspective as well as from ICE's perspective. Technical risks are very low. It is therefore recommended that the project be implemented as described above. A detailed implementation plan is outlined in the following chapter.

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CHAPTER 3: DETAILED PROJECT WORK PLAN

In this chapter, the proposed activities for implementing the pilot project are described and a detailed work plan is proposed for each category of participants: ICE; the participating facilities; the consultants; and other parties at interest such as equipment suppliers, CNFL, and DSE.

The proposed activities are organized into three phases:

Phase 1: Startup

Phase 2: Demonstration

Phase 3: Dissemination

PHASE 1: STARTUP

This phase is the most critical, as it defines all the prerequisites for the project and the precise role of each participant.

ICE Activities

1. <u>Organize workshop</u>

During the first month of the project, ICE will organize a workshop for the management of participating facilities to explain in detail the purpose and content of the project and its precise objectives and conditions. Hagler, Bailly will help prepare letters of invitation providing a detailed project description and presenting the duties of each party, i.e., ICE, the participating companies, and the consultants. The workshop should be chaired by a top ICE official and the Minister of Natural Resources, Energy and Mines should make a brief statement on the national importance of the project.

2. Finalize selection of target facilities

In addition to the 15 candidates selected from the list of facilities visited, an additional 20 will be preselected on the basis of their maximum load and their potential for load reduction in the view ICE personnel in charge of these customers (see Exhibit 3.1). Quick visits will be made to all 20 facilities by two groups of ICE specialists from the Quality Control Office or QCO (who accompanied the consultants during the first 22 visits and participated actively in the discussions).

3. Assign staff roles

- Select project director
- Decide which department of ICE will be responsible for day-to-day activities and implementation (probably the QCO)
- Make two people available on a full-time basis from the selected department for the duration of the project.

4. Finalize metering and monitoring procedures

QCO personnel are well informed about the technology and the procedures to be followed. However, decisions will have to be made at the beginning of the project on equipment use:

- Of the first batch of Sangamo electronic meters available, which facilities will receive the five not yet allocated?
- What is the plan for installing the next batch of 75 to ensure that the system is ready for monitoring by the end of the first month of the project?

Exhibit 3.1

List of Potential Additional Candidates

	Plant Name	Activity	KW	kWh/Month
1.	CEMPA	Cement	415.00	155,000
2.	Hacienda La Luis S.A.	Sugar	398.00	270,000
3.	Avicola La Garita	Food	206.61	101,184
4.	Cartago Beef Packing	Meat Packing	855.00	410,000
5.	Cia. Minera Esperanza S.A.	Minerals	316.89	129,499
6.	Ingenio Taboga S.A.	Sugar	1,200.00	270,000
7.	Consejo Nal. Produccion	Slaughterhouse	640.08	241,692
8.	Beneficio El General S.A.	Coffee Processing	450.84	217,464
9.	Cia. Bananera de C.R.	Veg. Oil	402.69	159,916
10.	Cia. Bananera de C.R.	Veg. Oil	335.00	97,000
11.	Ricalit S.A.	Fabrica	740.00	295,400
12.	Envaco Med. # 1	Fab. Boxes	325.00	110,000
13.	Florencia Cofee Co	Sugar	530.04	194,890
14.	Hacienda Atirro Ltda.	Coffee Processing	250.00	55,000
15.	Hacienda Atirro Ltda.	Sugar	200.00	45,000
16.	Talmana S.A.	Seafood Packing	264.38	126,316
17.	Azucarera El Palmar S.A.	Sugar	1,062.25	701,750
18.	Empacad. Carne C.R.S.A.	Meat Packing	1,038.24	430,500
19.	Crown Cork S.A.	Cork	545.76	157,364
20.	C.N.P. Montecillos	Slaughter House	640.08	241,692
		Total (rounded)	**10,817**	**4,410,000**

Source: ICE

5. **Install meters at selected sites and phone lines**

This step is required to established a baseline for measuring future load reductions as early as possible.

6. **Install computer and test system**

A computer was ordered in November 1987 and is expected to arrive in early January (see Appendix C for details). It will allow the project staff to monitor the progress made on the individual and aggregate loads of the sample customers on a permanent basis. A critical activity here will be the testing and "debugging" of the system, the possible adaptation/modification of the software, and the calibration of the equipment.

7. **Develop sample outputs**

This step will consist of defining the type of output needed, e.g., tables, charts, and graphs for selected groups of customers; time intervals; and type of activity. All these activities must be completed by the end of the second month.

Activities of Participating Facilities

1. **Finalize agreement/arrangements**

Participating facilities will be invited to the opening workshop and will be asked formally to participate in the pilot project (most of the 15 plants have already agreed verbally). A letter will be prepared defining the terms of the project. Two key elements of the agreements will be:

- The commitment of the facility to purchase and install at its own expense the control equipment recommended by the consultants and mutually agreed on.
- The authorization to use the results of the demonstration for information dissemination purposes.

2. **Identify/select control systems**

With assistance from ICE and the consultants, the participating facilities will select the equipment needed. Equipment may consist of an EMS, a computerized system and more simple switches (e.g., timers). All facilities should have selected their equipment by the end of the third month.

3. **Order equipment**

Some facilities will be able to order their equipment in the first month, but for others, a feasibility study may be required. Of the 15 facilities selected, 3 fall into this latter category. For these facilities, the order will not be placed before the third month.

4. **Set up internal organization**

Staff must be assigned to oversee the proper operation of the control system and take appropriate actions when needed, e.g., in case of an anomaly in the production process.

Activities of Suppliers and Consultants

1. **Help facilities select equipment**

Because of the market that this pilot project is likely to create, it may be possible to involve a number of U.S. equipment vendors in the project as suppliers of free equipment for demonstration purposes. Such vendors may include Sangamo, Westinghouse, Bailey Controls, and Honeywell. There are also consultants in Costa Rica that are knowledgeable about these systems and whose input may be useful to the facilities (which would pay for the services). During the first month, selected U.S. equipment vendors and Costa Rican specialized consultants will be contacted to discuss and finalize the terms of their participation.

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Activities of Hagler, Bailly and FPL Qualtec

1. **Draft typical letter of agreement for project participants**

ICE and USAID will provide input to the letter of agreement prepared by Hagler, Bailly for participating facilities.

2. **Provide technical assistance to participants**

Hagler, Bailly and FPL will provide technical assistance to the project as described in their contract with USAID. As part of their chief activities, they will collect detailed information from U.S. suppliers about candidate control systems for participating facilities (see Appendix C) and will conduct feasibility studies where required (with support from local consultants).

3. **Train ICE/industry engineers/counterparts/consultants**

During the course of the project, Hagler, Bailly and FPL will provide ongoing on-the-job training in all aspects of industrial and commercial load management.

4. **Draft interim report**

An interim report describing progress to date and major problems encountered will be prepared by the end of the fourth month.

DSE Activities

DSE staff members will be invited to key meetings to provide input and will receive key reports for their comment.

PHASE 2: DEMONSTRATION

The demonstration activity -- monitoring peak loads at participating sites -- will start as early as the end of the first month in cases where no sophisticated systems are needed,

e.g., manually stopping some large electric motors on process lines. Monitoring at all participating sites is expected to be under way by the end of the fourth month.

ICE Activities

1. **Collect data/monitor progress at each site**

Daily load curves and detailed data for evening peak periods will be gathered and monitored on a daily basis.

2. **Visit sites**

Random visits and visits prompted by the perception or identification of a problem will be made to verify or correct the operation of the control system and the monitoring devices.

3. **Track impact on peak load**

Summary graphics will be plotted to monitor the decrease in individual and group peak loads over time.

Activities of Participating Facilities

1. **Install equipment**

Suppliers and local consultants may provide assistance where the installation is complex.

2. **Implement load management program**

Concerned staff members will become familiar with the equipment and adjust their activities and habits to the new operation.

Activities of Hagler, Bailly and FPL

By the end of the sixth month, Hagler, Bailly and FPL will start analyzing the preliminary results of the project from a cost/benefit standpoint.

PHASE 3: DISSEMINATION

ICE Activities

1. **Fine tune cost/benefit data**

The estimate of the benefits will be provided by Hagler, Bailly and FPL. Cost information will include total costs incurred by the participating facilities and costs to ICE (monitoring system, computer, software, and meters).

2. **Identify impact of demonstration over long term**

This task will be carried out in close collaboration with Hagler, Bailly and FPL. It will consist of projecting future loads at participating facilities and estimating possible impact of future load reductions.

3. **Estimate replicability**

Based on detailed load information available at ICE and CNFL, the impact of expanding the project to a larger segment of the industrial and commercial sectors will be estimated.

4. **Develop dissemination plan**

A plan for disseminating the information gathered during the pilot project will be prepared with assistance from Hagler, Bailly and FPL. ICE will be responsible for the final plan.

5. **Prepare pamphlets and dissemination campaign materials**

These documents will be prepared with assistance from Hagler, Bailly and FPL, but the final decision and the distribution plan will rest with ICE. Numerous examples from the U.S. will be brought to ICE by Hagler, Bailly and FPL Qualtec to be used in their design.

Activities of Participating Facilities

1. **Prepare short report documenting experience**

Each participating facility will prepare a 4-5 page report documenting the reasons why it joined the project, its original expectations, the selection of the control system, the results achieved, and the problems encountered as well as some recommendations for ICE and other customers. This requirement will be mentioned in the letter of agreement.

2. **Allow site visits**

Per the letter of agreement, the facilities will allow one or two site visits by outside parties.

3. **Suggest additional steps**

Participating facilities could send a short letter to ICE outlining additional steps that could be taken in the short term to reduce the peak load even more.

Activities of Hagler, Bailly and FPL

According to the terms of reference of their contract Hagler, Bailly and FPL will carry out the following tasks:

- Analyze load data

- Conduct detailed cost/benefit analysis
- Prepare overall conclusions/recommendations
- Prepare final report

The project will be completed at the end of the tenth month. Exhibit 3.2 depicts the overall schedule and responsibilities.

EXHIBIT 3.2

COSTA RICA LOAD MANAGEMENT PROGRAM
Detailed Work Plan (1988)
(As of March 1988)

MONTH

	1	2	3	4	5	6	7 - 9	10	11
A. START UP									
ICE									
1. Organize kick off workshop (opening seminar)	--0								
2. Finalize selection of target facilities		=====0							
3. Assign staff roles	=====0								
4. Finalize metering and monitoring procedures	=====0								
5. Install meters at selected sites	===0								
6. Install computer/test	-----0								
7. Develop sample output		---===0							
PARTICIPATING INDUSTRIES									
1. Finalize arrangement/agreement	===0								
2. Identify/select control system	==========0								
3. Order equipment	==========0								
4. Set up internal organization	======0								
SUPPLIERS/CONSULTANTS									
1. Assist industries select equip/def specs	==========0---								
HBC/FPL									
1. Draft typical letter of agreement for indu.	==0								
2. Provide Tech. Assistance to participants	==========0---								
3. Train ICE/industry engineers/counterparts	==========0----								
4. Draft interim report				====0					
DSE									
1. Participate in kick off workshop/meetings	=0			0			0		
B. DEMONSTRATION									
ICE									
1. Collect data/monitor progress at each site	==========0----								
2. Visit sites (at random)	*	*	*	*	*	*	*	*	
3. Track impact on peak load	==========0----								
PARTICIPATE INDUSTRIES									
1. Install equipment	==========0								
2. Implement load management program (gradually)	==========0----								
HBC/FPL									
1. Collect cost/benefit data and provide ad hoc T.A.		----------==========0----							
C. DISSEMINATION									
ICE									
1. Fine tune cost/benefit data			---==========0						
2. Identify impact of demos over long term (seasons)							====0		
3. Estimate replicability (list of candidate facilities)							========0		
4. Develop dissemination plan							=======0		
5. Prepare pamphlets and campaign for specialized magazines							--------========		
PARTICIPATING INDUSTRIES									
1. Prepare short report documenting experience							====0		
2. Allow site visits						----------			
3. Prepare programs for further steps							====0		
HBC/FPL									
1. Analyze load data									
2. Conduct detailed cost/benefit analysis							=====0		
3. Prepare overall conclusions and recommendations						---------========			
4. Prepare final report							====0		
CLOSING WORKSHOP (ICE & HBC/FPL)							=======0		
								*	

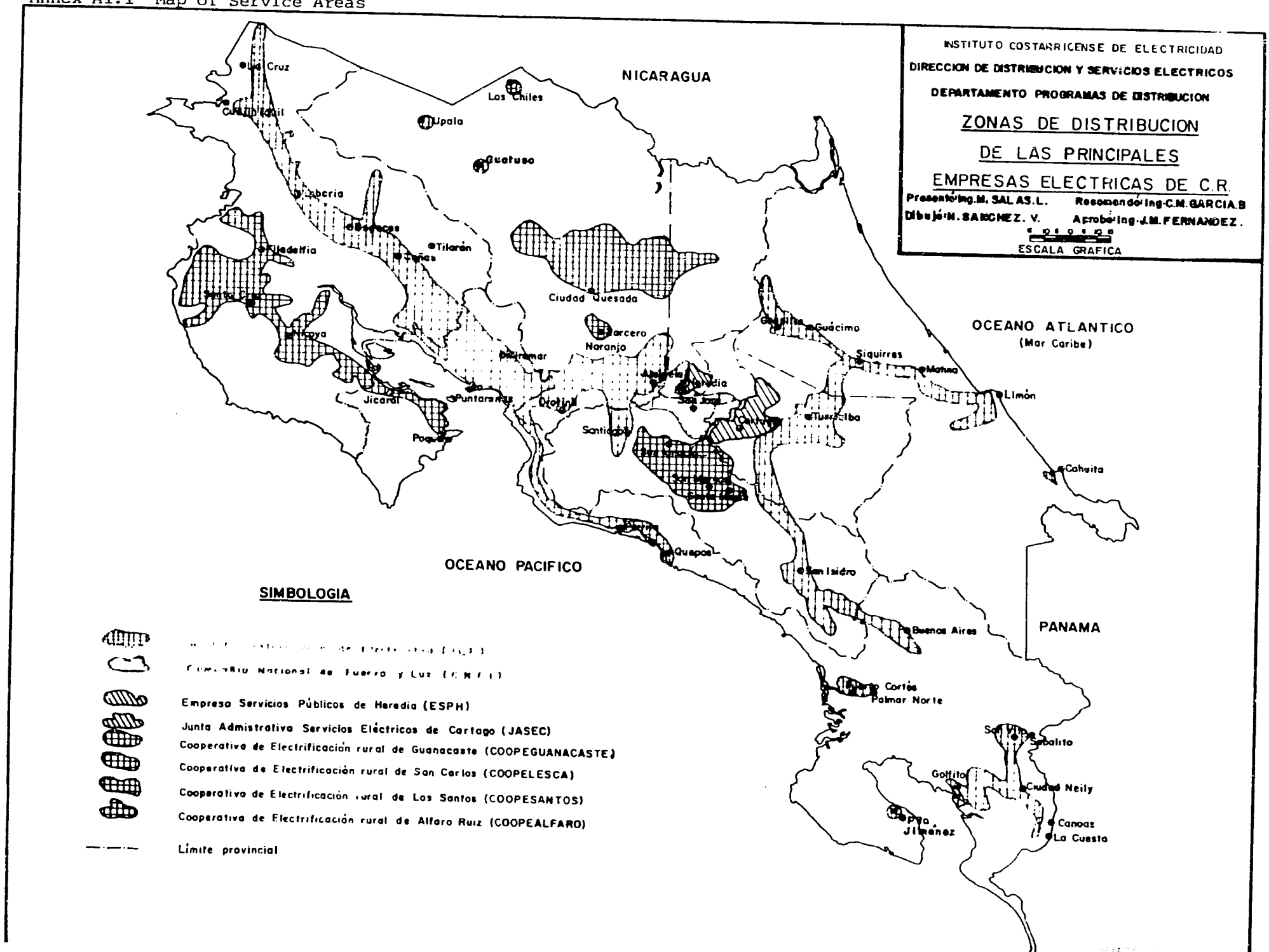
APPENDIX A: LOAD DATA

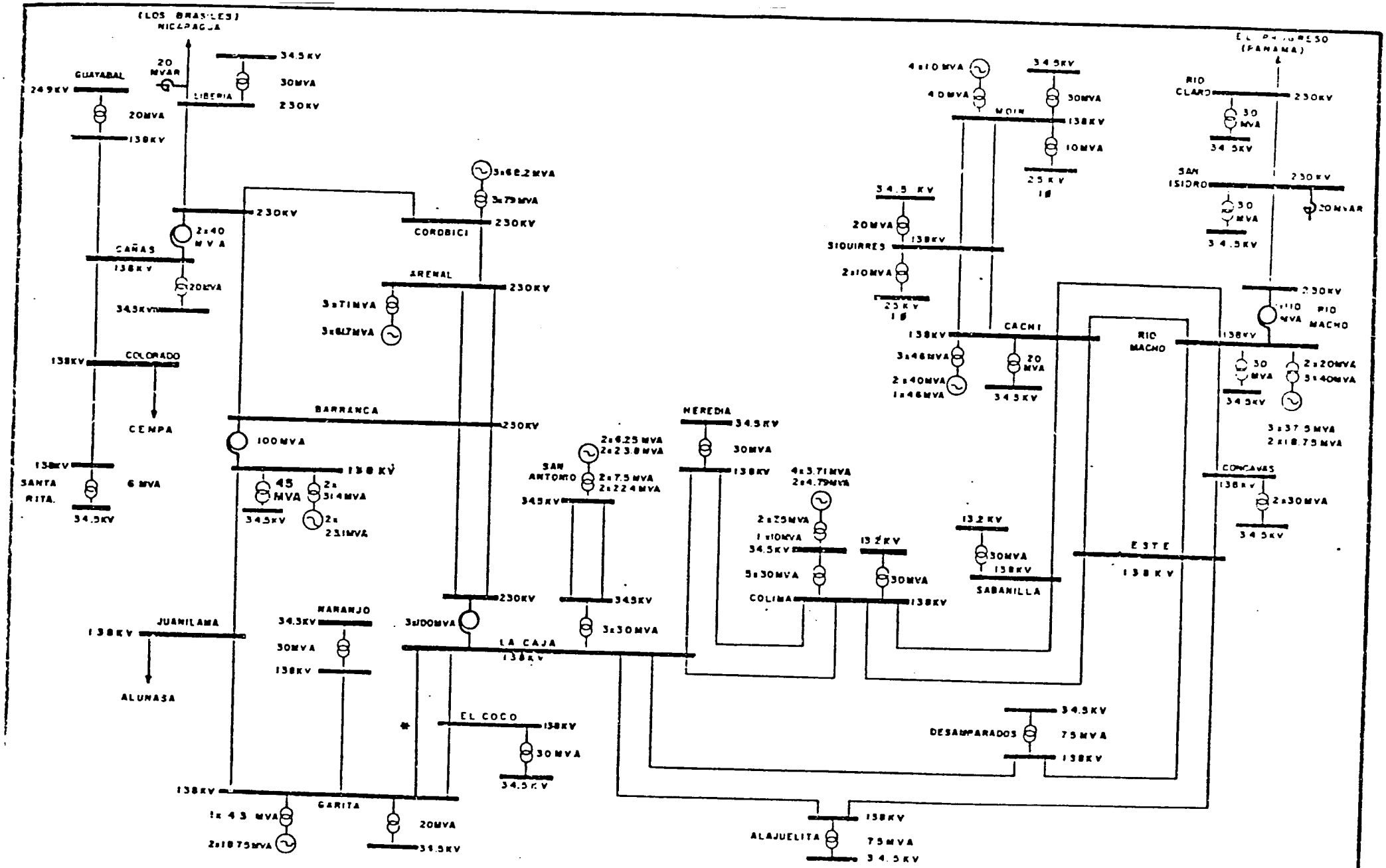
Supporting Annexes

The following pages present several annexes which contain valuable supporting information. These annexes are organized as follows.

Annexes	Information
1.1	Map of Service Areas
1.2	Single Line Diagram
1.3	Load Forecasts: Medium-Low-High
1.4	Key Characteristics of Generation Projects
1.5	Power & Energy Balances Under Medium Growth
1.6	Generation Expansion Plan Under Low & High Growth
1.7	Peak Day Load Curves 1982-1985
1.8	Weekday, Weekend, and Typical Summer Day and Winter Day System Hourly Load Curves
1.9	Load Curves for Households
1.10	Load Curves for Selected Industries
1.11	List of ICE's Large Customers
1.12	List of CNFL's Large Customers
1.13	Response to T8 Tariff

Annex A1.1 Map of Service Areas





* OBRA O SUBESTACION PROXIMA A ENTRAR EN SERVICIO.

DEPARTAMENTO TRANSMISION DE ENERGIA

LINEAS DE TRANSMISION DE 138 Y 230 KV

PLANTAS Y SUBESTACIONES DEL I.C.E

DICIEMBRE 86

Annex A1.3

OFICINA DE TARIFAS - MERCADO ELECTRICO
MERCADO ESCENARIO ALTO

AÑOS	RESIDENCIAL GWH	RESIDENCIAL % CREC	GENERAL GWH	GENERAL % CREC	INDUST MENOR GWH	INDUST MENOR % CREC	GRANDES INDUST GWH	GRANDES INDUST % CREC	ALUMBRADO PUBL GWH	ALUMBRADO PUBL % CREC	TOTAL DE VENTAS GWH	TOTAL DE VENTAS % CREC	GENERAC GWH	FC (1)	DEMANDA MW	GEN-IN % DEL TOT	AÑOS
1984	1243		606		525		212		82		2673		2985	0.5612	585	1347	50.41	1986
1985	1367	10	670	10	556	6	221	5	84	2	2909	8.89	3222	0.5257	620	1456	50.13	1987
1986	1486	6.7	730	9	591	6	242	9	85	2	3145	8.09	3456	0.5134	671	1572	50.02	1988
1987	1584	6.7	779	7	626	6	273	9	87	2	3342	6.93	3694	0.5600	716	1690	50.23	1989
1988	1689	6.7	832	7	664	6	299	9	89	2	3568	6.94	3955	0.5413	764	1815	50.48	1990
1989	1926	6.7	883	6	704	6	326	9	91	2	3945	6.55	4231	0.5622	815	1952	50.70	1991
1990	2055	6.7	1073	8	751	6	356	9	92	2	4114	6.97	4525	0.5941	870	2095	50.93	1992
1991	2193	6.7	1159	8	839	6	388	9	94	2	4401	6.98	4841	0.5954	928	2251	51.15	1993
1992	2340	6.7	1251	8	889	6	422	9	96	2	4706	6.99	5180	0.5969	991	2420	51.38	1994
1993	2497	6.7	1352	8	942	6	460	9	98	2	5038	7.01	5543	0.5981	1058	2601	51.61	1995
1994	2664	6.7	1460	8	999	6	502	9	100	2	5393	7.02	5932	0.5965	1130	2795	51.84	1996
1995	2843	6.7	1576	8	1058	6	547	9	102	2	5773	7.03	6346	0.6009	1206	3005	52.07	1997
1996	3033	6.7	1703	8	1122	6	596	9	104	2	6178	7.04	6798	0.6021	1288	3231	52.30	1998
1997	3236	6.7	1839	8	1189	6	650	9	106	2	6614	7.05	7275	0.6035	1376	3474	52.53	1999
1998	3453	6.7	1986	8	1261	6	708	9	108	2	7081	7.07	7789	0.6048	1470	3736	52.77	2000
1999	3685	6.7	2145	8	1336	6	772	9	110	2	7582	7.06	8341	0.6062	1571	4019	53.00	2001
2000	3933	6.7	2316	8	1416	6	842	9	113	2	8120	7.09	8932	0.6075	1678	4323	53.24	2002
2001	4195	6.7	2502	8	1501	6	917	9	115	2	8698	7.10	9568	0.6089	1794	4650	53.47	2003
2002	4476	6.7	2702	8	1591	6	1000	9	117	2	9315	7.11	10247	0.6102	1917	5003	53.71	2004
											9979	7.12	10977	0.6116	2049	5363	53.95	2005

(1) FC = 30.38 * LN (% GEN E IND) - 60
donde % GEN E IND = % que el general e industrial representan del total de ventas de energía

1.4

7.7 7.4 7.6

1.3 7.7

COSTA RICA PROYECCION DE DEMANDA DE ELECTRICIDAD

ESCENARIO MEDIO BID TC A EST CON
= 1 47 TC 0 ABON RESIDENCIALES

30/08/87

AGOS	DEMANDA COMERCIAL (GWH)	DEMANDA COMERCIAL %CREC	DEMANDA RESIDENCIAL (GWH)	DEMANDA RESIDENCIAL % CREC	DEMANDA IND MENOR (GWH)	DEMANDA IND MENOR %CREC	DEMANDA GRAND IND (GWH)	DEMANDA GRAND IND %CREC	ALUMBRADO PUBLICO %CREC	ALUMBRADO PUBLICO (GWH)	DEMANDA TOTAL (GWH)	DEMANDA TOTAL %CREC	GENERACION (GWH)	GENERACION %	GENERACION (MW)	AGOS
1986	608 76		1240 51		525 76		212 00			82 00	2671 03		2966 00	0 660	564 63	1986
1987	681 27	6 83	1287 91	3 85	555 65	5 69	232 00	9 43	2 00	83 54	2820 52	5 60	3122 57	0 605	587 35	1987
1988	714 50	6 05	1333 58	3 55	588 69	5 94	252 00	8 62	2 00	85 31	2974 09	5 44	3277 50	0 607	615 25	1988
1989	764 42	6 99	1372 97	2 95	622 84	5 46	274 00	8 73	2 00	87 02	3115 27	4 66	3431 20	0 610	642 11	1989
1990	812 23	6 25	1406 29	2 57	653 48	5 25	303 00	10 58	2 00	88 76	3265 74	4 70	3592 32	0 614	667 88	1990
1991	860 61	5 96	1445 98	2 88	685 57	4 91	325 00	7 28	2 00	90 53	3407 65	4 35	3748 46	0 617	692 52	1991
1992	915 43	6 37	1486 53	3 01	719 85	5 00	355 00	9 23	2 00	92 35	3572 16	4 83	3928 37	0 620	722 48	1992
1993	976 94	6 69	1537 22	3 20	755 20	5 05	387 00	9 01	2 00	94 15	3751 25	5 01	4126 38	0 622	757 31	1993
1994	1046 53	7 16	1595 43	3 79	796 28	5 30	421 00	8 79	2 00	96 00	3955 31	5 44	4350 84	0 625	794 67	1994
1995	1129 85	7 97	1667 75	4 53	843 06	5 88	461 00	9 26	2 00	98 00	4196 75	6 15	4615 42	0 627	840 88	1995
1996	1224 46	8 36	1750 24	4 95	888 17	6 00	501 00	8 91	2 00	99 96	4471 84	6 50	4919 02	0 629	892 74	1996
1997	1330 15	8 62	1845 69	5 47	954 67	6 55	544 00	8 98	2 00	101 98	4776 97	6 87	5256 87	0 631	951 03	1997
1998	1447 04	8 79	1950 52	5 66	1015 85	6 70	593 00	8 97	2 00	104 00	5115 40	7 04	5626 94	0 634	1013 16	1998
1999	1574 92	8 84	2063 21	5 79	1088 39	6 82	645 00	8 81	2 00	106 08	5480 59	7 14	6028 65	0 636	1082 38	1999
2000	1714 91	8 89	2183 10	5 81	1163 21	6 87	707 00	9 10	2 00	108 20	5876 42	7 22	6464 06	0 639	1155 58	2000
2001	1868 28	8 94	2310 74	5 85	1242 18	6 86	770 00	8 91	2 00	110 36	6302 57	7 25	6932 82	0 645	1227 00	2001
2002	2036 36	9 00	2446 68	5 88	1328 65	6 88	839 00	8 96	2 00	112 57	6763 28	7 31	7439 59	0 652	1300 56	2002
2003	2220 67	9 05	2591 50	5 92	1420 00	6 87	915 00	9 06	2 00	114 87	7261 98	7 37	7986 19	0 660	1381 56	2003
2004	2422 66	9 10	2745 85	5 96	1517 62	6 88	997 00	8 96	2 00	117 12	7800 45	7 41	8585 49	0 665	1472 84	2004
2005	2644 79	9 16	2910 39	5 99	1621 56	6 88	1087 00	9.03	2 00	119 46	8383 80	7 46	9224 96	0 671	1566 90	2005
		7 61		4 61		6 11		7 0	2 %		5 21			6 11		5 51

(1) 2% 1988, 5% 1989-1991, 3% 1992-1993, 2% 1994

COSTA RICA PRONOSTICOS DE DEMANDA DE ELECTRICIDAD

ESCENARIO BAJO BID CON 1- TC A ESP CON = 1 47 TC A AFGA RESID
2- TC ABON RESID 4% HASTA EL 31 DEL 91 AL 2005 TC DE POBLAC

02/06/87

AÑOS	DEMANDA COMERCIAL (GWH)	DEMANDA COMERCIAL %CREC	DEMANDA RESIDENCIAL (GWH)	DEMANDA RESIDENCIAL % CREC	DEMANDA IND MENOR (GWH)	DEMANDA IND MENOR %CREC	DEMANDA GRANDE IND (GWH)	DEMANDA GRANDE IND %CREC	ALUMBRADO PUBLICO %CREC	ALUMBRADO PUBLICO (GWH)	DEMANDA TOTAL (GWH)	DEMANDA TOTAL %CREC	GENERACION (GWH)	GENERACION FC	GENERACION (MW)	AÑOS
1986	601 76		1242 51		525 76		212 00			32 00	2611 03		2956 30	0 602	564 46	1986
1987	662 22	8 78	1289 20	3 76	555 69	5 69	232 00	9 43	2 00	33 64	2832 75	5 68	3105 02	0 603	587 03	1987
1988	715 27	8 16	1335 66	3 60	588 55	5 94	252 00	8 62	2 00	35 31	2976 10	5 5	3235 67	0 607	614 66	1988
1989	766 82	7 06	1375 95	3 00	620.86	5 46	274 00	8 73	2 00	37 02	3124 64	4 92	3437 11	0 610	643 22	1989
1990	814 85	6 26	1411 56	2 59	653 46	5 25	303 00	10 58	2 00	38 76	3271 74	4 71	3582 51	0 614	665 11	1990
1991	847 73	3 29	1424 03	0 85	685 57	4 91	325 00	7 26	2 00	40 53	3366 86	2 91	3730 55	0 617	693 22	1991
1992	871 93	2 59	1440 35	1 15	719 85	5 00	355 00	9 23	2 00	42 35	3429 47	3 54	3827 42	0 620	724 71	1992
1993	904 69	3 76	1458 18	1 24	756 20	5 05	387 00	9 01	2 00	44 19	3600 26	3 47	3960 28	0 622	726 83	1993
1994	941 23	4 04	1482 87	1 69	796 28	5 30	421 00	8 79	2 00	46 08	3737 42	3 81	4111 16	0 625	755 90	1994
1995	984 52	4 60	1516 57	2 27	843 06	5 88	460 00	9.26	2 00	48 00	3852 14	4 41	4282 38	0 627	791 49	1995
1996	1031 35	4 76	1554 85	2 52	896 17	6 30	501 00	8 91	2 00	49 96	4083 33	4 44	4451 66	0 629	825 18	1996
1997	1080 97	4 81	1589 94	2 80	954 87	6 55	546 00	8 98	2 00	52 06	4293 74	4 97	4712 11	0 631	852 48	1997
1998	1134 09	5 91	1646 81	3 05	1018 85	6 70	595 00	8 97	2 00	54 00	4500 74	5 07	4950 81	0 634	891 42	1998
1999	1189 81	4 91	1700.47	3 13	1088 36	6 82	648 00	8 91	2 00	56 08	4732 75	5 15	5206 02	0 636	934 43	1999
2000	1248 28	4 91	1752 58	3 06	1163 21	6 87	707 00	9 10	2 00	58 20	4978 27	5 25	5477 16	0 638	980 02	2000
2001	1309 82	4 91	1807 46	3 13	1243 18	6 86	770 00	8 91	2 00	60 36	5240 62	5 25	5764 69	0 640	1020 28	2001
2002	1375 97	4 91	1864 06	3 13	1328 65	6 88	836 00	8 96	2 00	62 57	5518 25	5 30	6070 08	0 642	1060 78	2002
2003	1447 48	4 91	1922 44	3 13	1420 00	6 87	915 00	9 06	2 00	64 82	5813 74	5 35	6395 11	0 660	1106 11	2003
2004	1519 31	4 91	1982 64	3 13	1517.62	6 88	997 00	8 96	2 00	67 12	6126 69	5 36	6739 36	0 665	1158 29	2004
2005	1596 63	4 91	2044 73	3 13	1621 96	6 88	1087 00	9 03	2 00	69 46	6459 77	5 44	7105 74	0 671	1208 60	2005
											4.9%		4.7%		4.1%	

(1) 2% 1986, 5% 1989-1991, 3% 1992-1993, 2% 1994

Annex 1-4

Key Characteristics of New Hydroelectric Generation Projects
in Expansion Plan 1/

Project	Installed Capacity (MW)	Capability		Annual Energy		Study Status	Capital Cost ($/kW) 2/	Cost of Operation		Energy Cost		Regulation Cycle
		Firm (MW)	Average (MW)	Firm (GWh)	Average (GWh)			Fixed ($/kW.mo.)	Variable ($/kWh)	Firm ($/kWh)	Average ($/kWh)	
Sandillal	32	32	32	140	140	Financing	1,276 (1393/1,421)	0.39	--	0.040	0.040	Daily
Angostura	177	167 (177) 3/	177	664	996	Feasibility	1,308 (1393/1,500)	0.39	--	0.050	0.033	Daily
Siquirres	154	154	154	630	760	Preliminary	1,399 (1,514/1,765)	0.39	--	0.053	0.044	Seasonal
Toro I	24	19 (24) 3/	24	72	118	Prefeasi-bility	809 (853/947)	0.39	--	0.040	0.024	Run-of-River
Toro II	66	60 (66) 3/	66	185	315	Prefeasi-bility	452 (486/529)	0.39	--	0.024	0.014	Daily
Sub-Total	453											

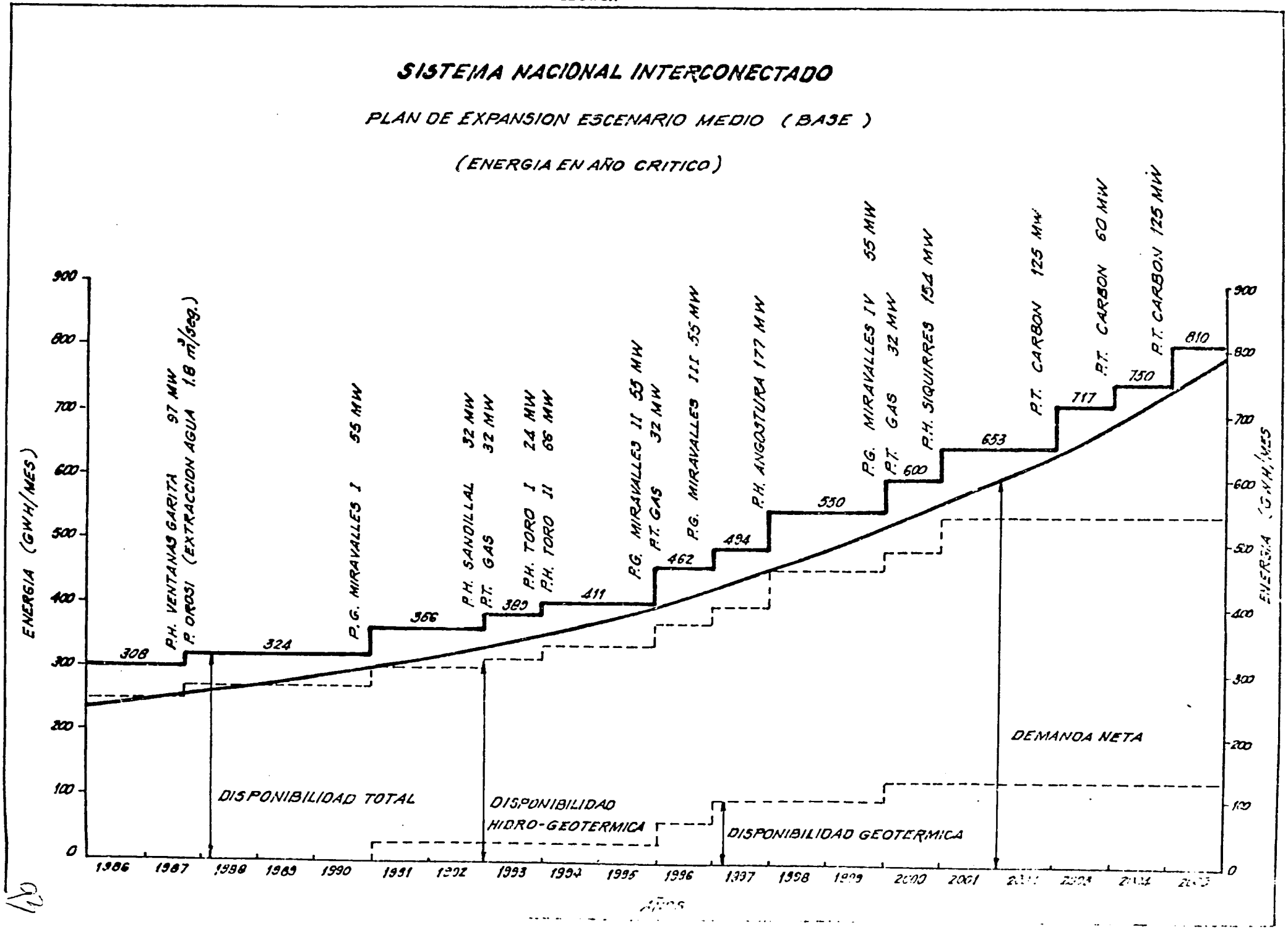
1/ Unless otherwise noted, all costs are in December 1986 border prices.
2/ First figure in parenthesis represents equivalent market prices for border cost stated above.
Second price in parenthesis represents capital cost and interest during construction.
3/ During rainy season.

Annex 1-4 (continued)

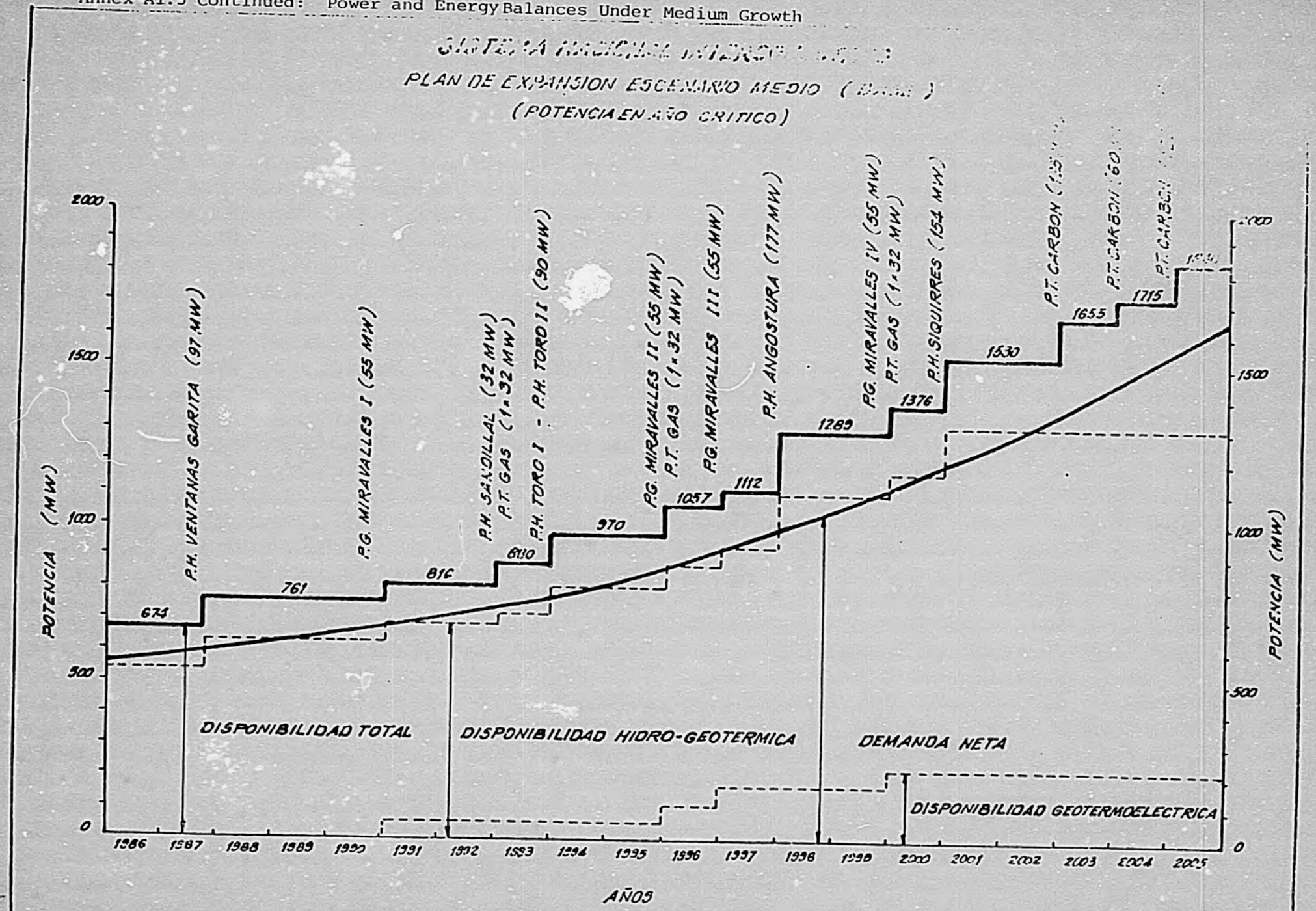
Key Characteristics of New Geothermal and Thermal Generation Projects in Expansion Plan 1/

Project	Installed Capacity (MW)	Annual Energy (GWh)	Study Status	Capital Cost ($/kW)	Cost of Operation: Fixed ($/kW.mo.)	Cost of Operation: Variable ($/kWh)	Fuel Cost ($/kWh)	Mode of Operation
Geothermal								
Miravalles I	55	389	Design	1,842 (2,300)	3.14	--	0.045	Baseload
Miravalles II	55	389	Feasibility	1,593 (1,659)	2.24	--	0.038	Baseload
Miravalles III	55	389	Prefeasi-bility	1,593 (1,659)	2.24	--	0.038	Baseload
Miravalles IV	55	389	Prefeasi-bility	1,593 (1,659)	2.24	--	0.038	Baseload
Sub-Total	220							
Thermal								
Gas Turbine	32	224	Design	558 (588)	0.13	0.94	0.013	Peak
Steam Turbine	60	368	Prefeasi-bility	1,351 (1,367)	2.67	2.39	0.039	Baseload
Steam Turbine	125	723	Prefeasi-bility	1,140 (1,154)	1.78	3.15	0.034	Baseload

1/ Unless otherwise noted, all costs are in December 1986 border prices. Figures in parenthesis represents equivalent market prices.


SISTEMA NACIONAL INTERCONECTADO
PLAN DE EXPANSION ESCENARIO MEDIO (BASE)
(ENERGIA EN AÑO CRITICO)
ENERGIA (GWH/MES)
ENERGIA (GWH/MES)
P.H. VENTANAS GARITA 97 MW
P. OROSI (EXTRACCION AGUA 1.8 m³/seg.)
P.G. MIRAVALLES I 55 MW
P.H. SANDILLAL 32 MW
P.T. GAS 32 MW
P.H. TORO I 24 MW
P.H. TORO II 66 MW
P.G. MIRAVALLES II 55 MW
P.T. GAS 32 MW
P.G. MIRAVALLES III 55 MW
P.H. ANGOSTURA 177 MW
P.G. MIRAVALLES IV 55 MW
P.T. GAS 32 MW
P.H. SIQUIRRES 154 MW
P.T. CARBON 125 MW
P.T. CARBON 60 MW
P.T. CARBON 125 MW
308
324
366
389
411
462
494
550
600
653
717
750
810
DISPONIBILIDAD TOTAL
DISPONIBILIDAD HIDRO-GEOTERMICA
DISPONIBILIDAD GEOTERMICA
DEMANDA NETA
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001

Annex A1.5 Continued: Power and Energy Balances Under Medium Growth



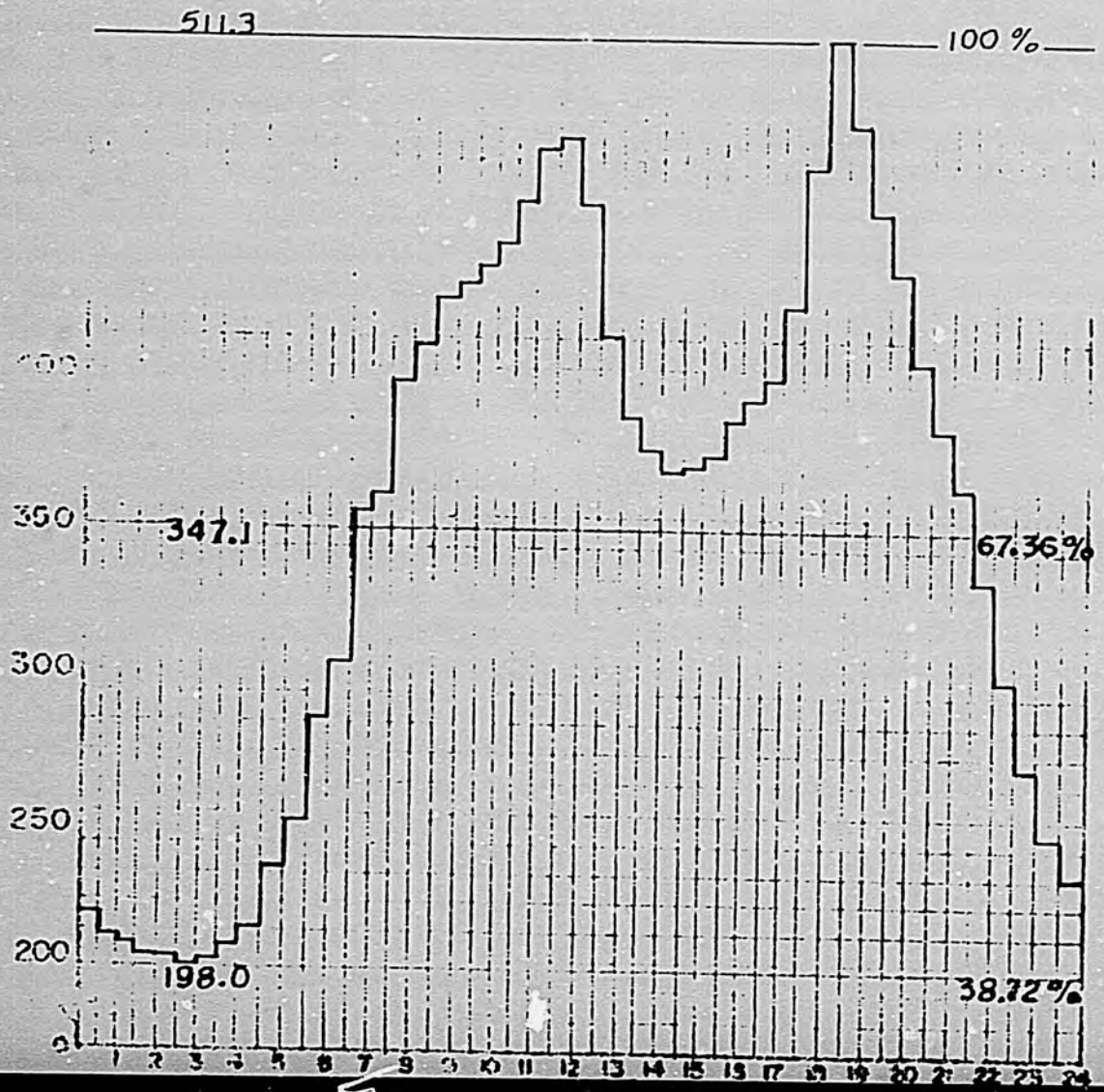
Annex 1-6

Generation Expansion Plan
Under Alternate Growth Scenarios

Year	Low Growth
1987	Ventanas Garita (96 MW)
1988	--
1989	--
1990	--
1991	--
	--
1992	Miravalles I (55 MW)
1993	--
	--
1994	Sandillal (32 MW)
	--
1995	Toro I (24 MW)
	Toro II (66 MW)
1996	--
	--
1997	Miravalles II (55 MW)
	--
1998	Miravalles III (55 MW)
1999	Gas (2 x 32 MW)
	--
2000	Miravalles IV (55 MW)
	--
2001	Gas (32 MW)
2002	Angostura (177 MW)
2003	--
2004	--
2005	Siquirres (154 MW)

Year	High Growth
1987	Ventanas Garita (96 MW)
1988	--
1989	--
1990	Gas (3 x 32 MW)
1991	Miravalles I (55 MW)
	Gas (32 MW)
1992	Gas (32 MW)
1993	Sandillal (32 MW)
	Miravalles II (55 MW)
1994	Toro I (24 MW)
	Toro II (66 MW)
	--
1995	Gas (2 x 32 MW)
1996	Angostura (177 MW)
	--
1997	Miravalles III (55 MW)
1998	Siquirres (154 MW)
1999	Miravalles IV (55 MW)
2000	Carbon (125 MW)
2001	Gas (2 x 32 MW)
2002	Carbon (125 MW)
2003	Carbon (125 MW)
2004	Carbon (125 MW)
	Gas (32 MW)
2005	Carbon (2 x 60 MW)
	Gas (32 MW)

Annex A1.7 Peak Day Load Curves 1982-1985



1985

511,3

TOTAL	8 329 985		67,88

DIRECCION PRODUCCION

MES : DICIEMBRE 1985

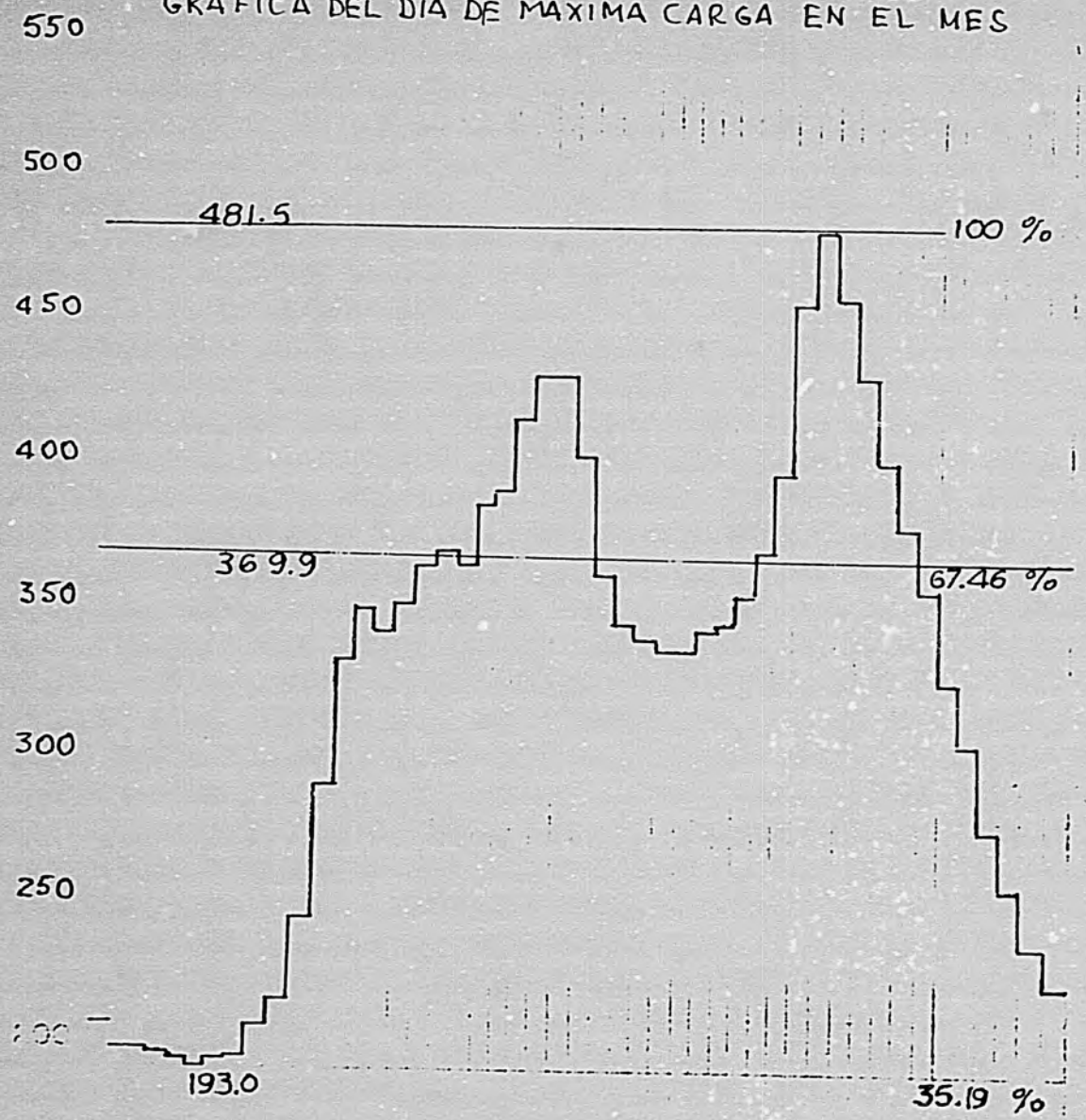
DIBUJO	REVISO	
CARLOS A. ARAYA Z.	ARMANDO MARCHAN B.	

CUADRO Nº4

SISTEMA NACIONAL INTERCONECTADO

GRAFICA DEL DIA DE MAXIMA CARGA EN EL MES

27 NOVIEMBRE 1984



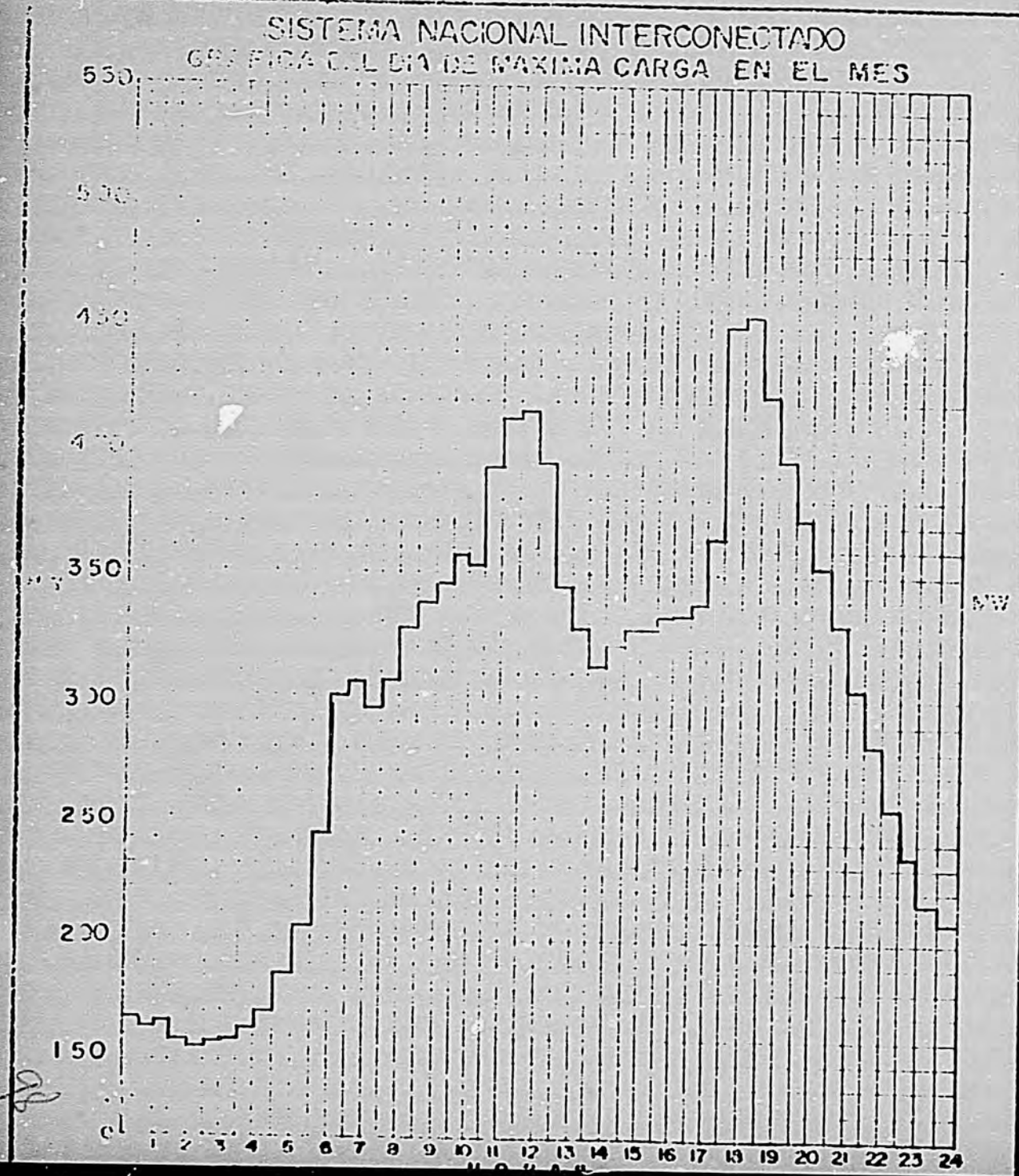
481,5

7 821 807

67,69

DIBUJO	REVISO	APROBO

Nº 4-A



DIA	HORA	FECHA	MES	AÑO
LUNES	18:00	21	NOVIEMBRE	1983
EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES CNFL-HIDRO ICE - HIDRO				
TOTAL			451,5	100.00
EMPRESAS	K W H		%	% CARGA
MENORES CNFL-HIDRO ICE - HIDRO				
TOTAL	7 051 415		100.00	65,07

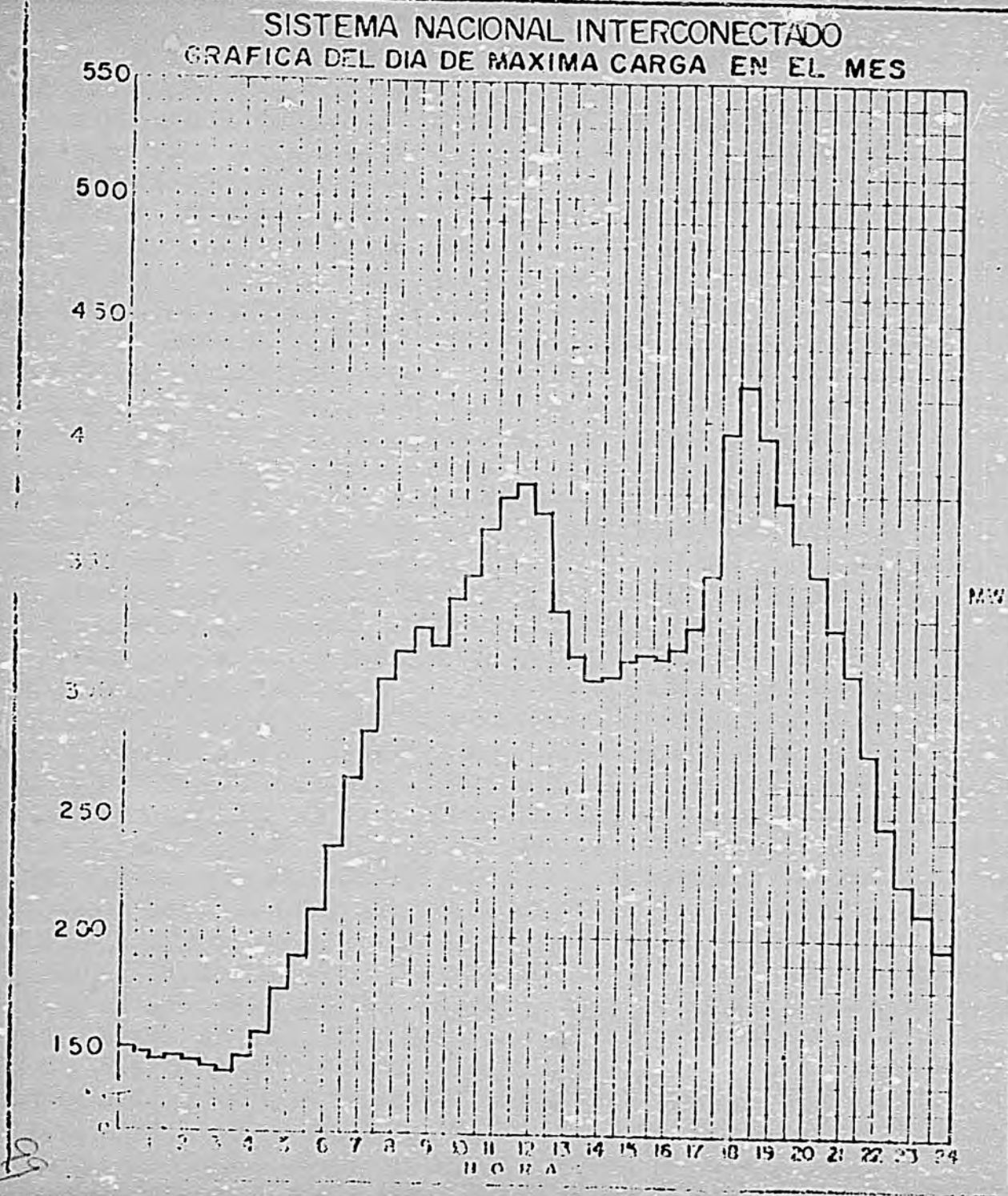
OBSERVACIONES:

I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA - CARGA DESPACHO

MES: NOVIEMBRE

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z.	ARMANDO STARCEVIC B.	ING. ARMANDO BALMA

CUADRO Nº 3 - A REPORTE Nº 11



DIA	HORA	FECHA	MES	AÑO
LUNES	18:00	6	DICIEMBRE	1982

EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMICO				
TOTAL		100.00	424.2	100.00

EMPRESAS	GENERACION		[illegible]
	K W H	%	DE CARGA
MENORES			
[illegible]			
ICE-TERMICO			
TOTAL	6 723 934	[illegible]	65,05

OBSERVACIONES:

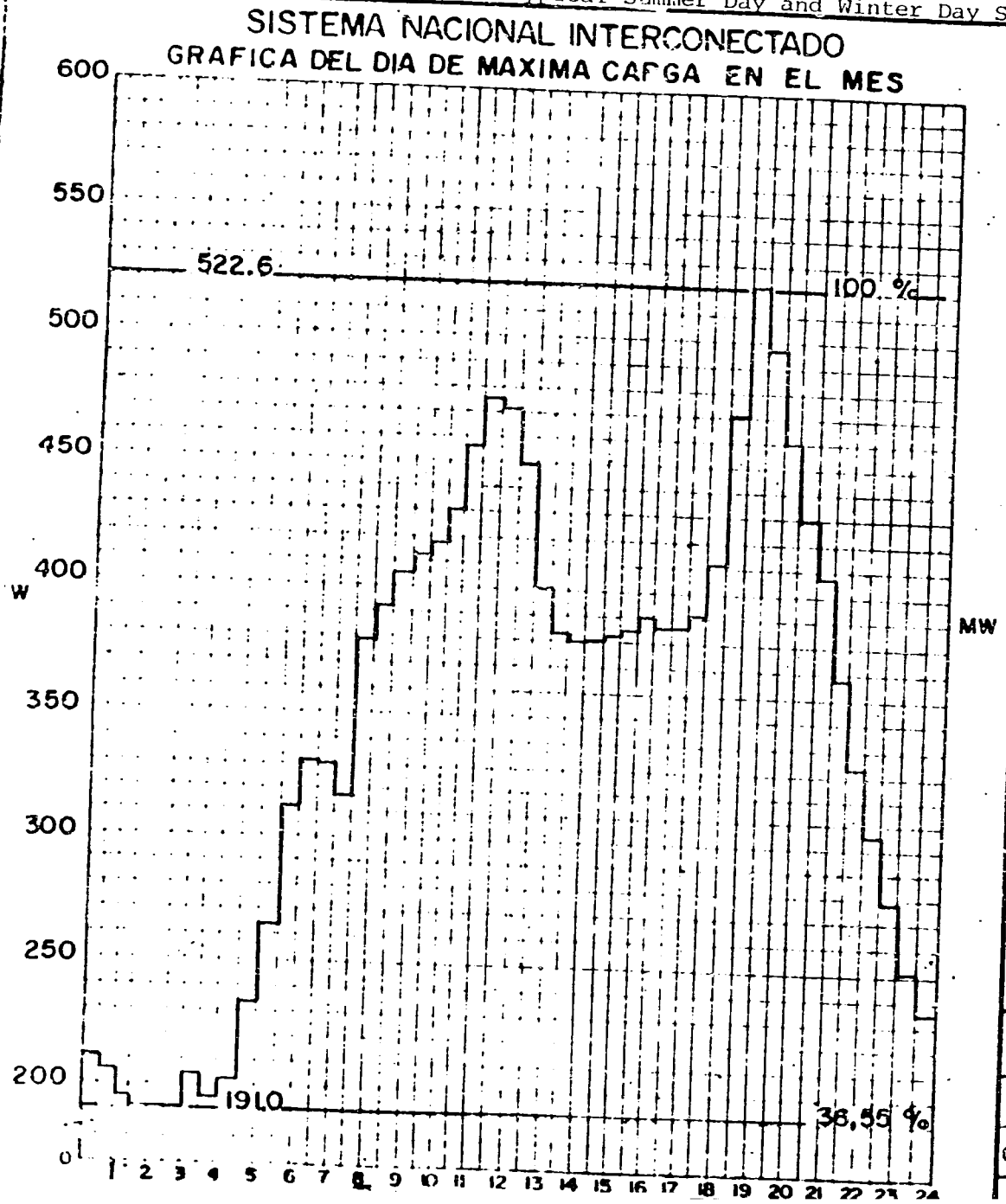
I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA-OFICINA ESTADISTICA

MES : DICIEMBRE

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z.	ARMANDO STARCEVIC B.	ING. ARMANDO [illegible]

CUADRO Nº 3-A | REPORTE Nº 12

Annex A1.8 Weekday, Weekend, and Typical Summer Day and Winter Day System Hourly Load Curves



DIA	HORA	FECHA	MES	AÑO
LUNES	16:30	17	MARZO	1986

EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMIC				
TOTAL		100.00	522,6	100.00

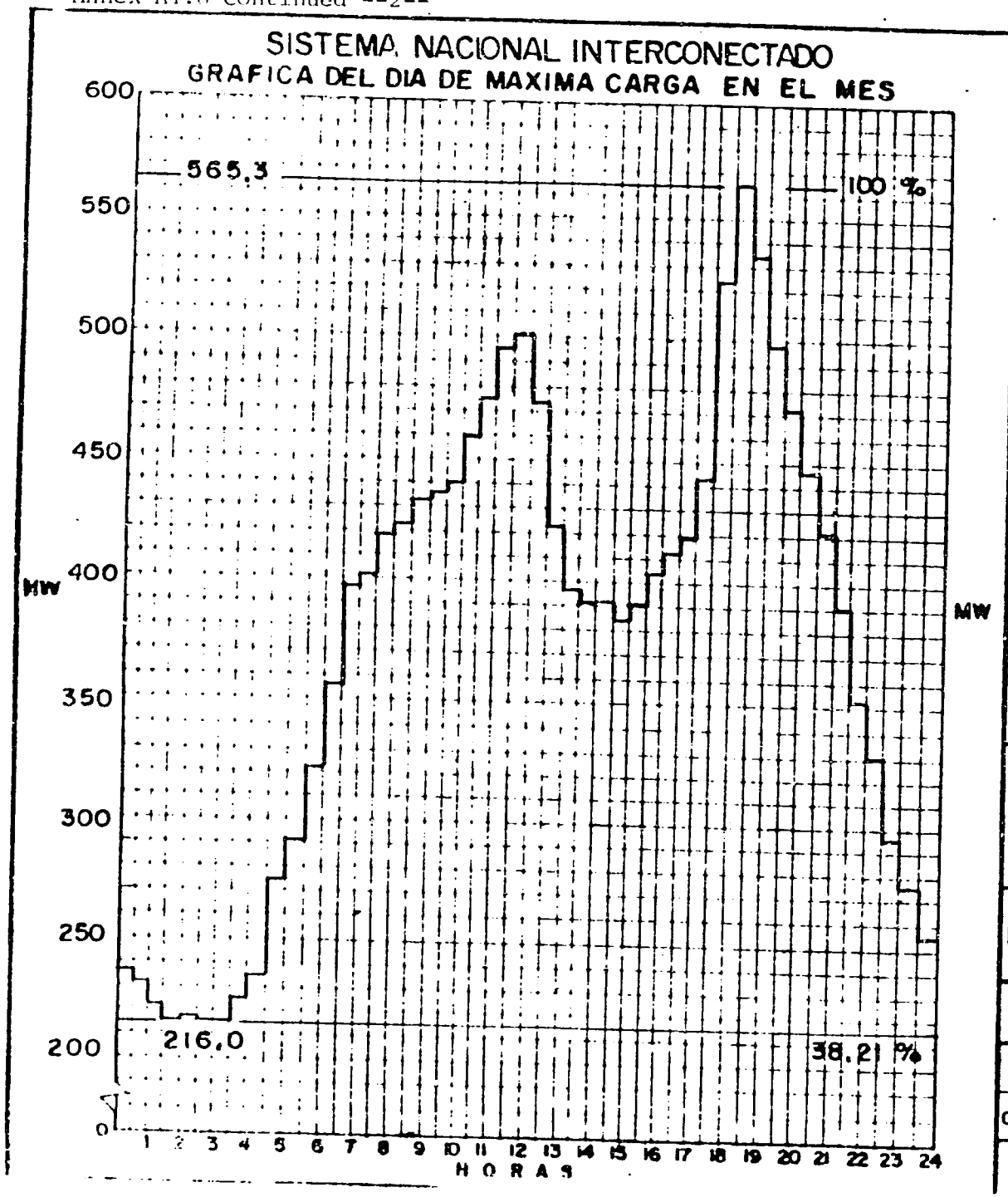
EMPRESAS	GENERACION		FACTOR DE CARGA
	K W H	%	
MENORES			
CNFL-HIDRO			
ICE - HIDRO			
ICE -TERMIC.			
TOTAL	8 316 723.	100.00	66,31

OBSERVACIONES: SISTEMA NACIONAL INTERCONECTADO:DE LA MAXIMA CARGA 13,2 MW SON IMPORTADOS DE HONDURAS.

I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA-OFICINA ESTADISTICA

MES : MARZO 1986

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z.	ARMANDO STARCEVIC B.	ING. ARMANDO BALMA



DIA	HORA	FECHA	MES	AÑO
MIERCOLES	18:00	26	NOVIEMBRE	1984

EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMIC				
TOTAL		100.00	565.3	100.00

EMPRESAS	GENERACION		FACTOR DE CARGA
	K W H	%	
MENORES			
CNFL-HIDRO			
ICE - HIDRO			
ICE -TERMIC.			
TOTAL	8 998 985	100.00	

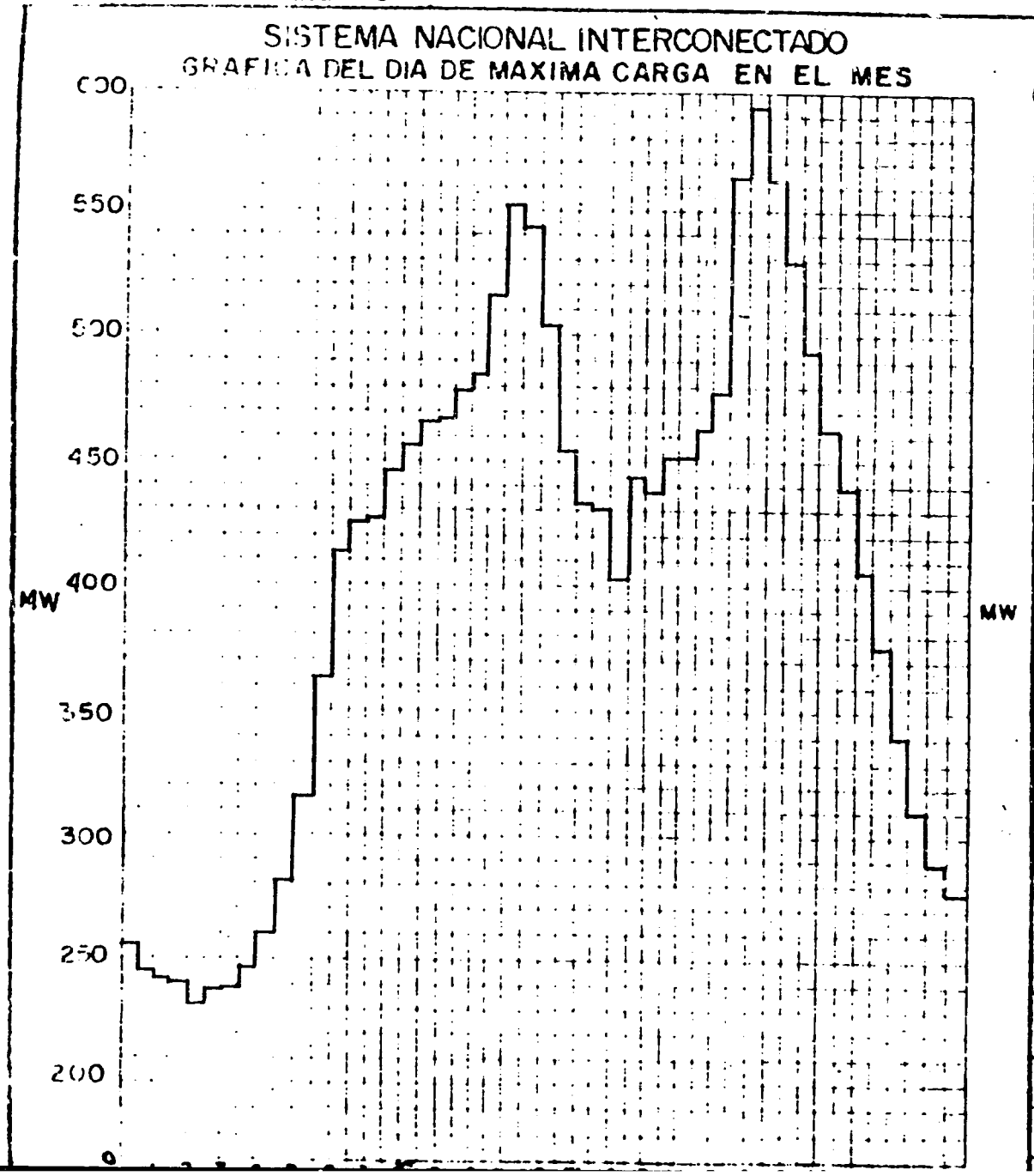
OBSERVACIONES: LA CURVA AQUI INDICADA PERTENECE A LA CARGA MAXIMA DEL PAIS.-

I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA-OFICINA ESTADISTICA

MES : NOVIEMBRE 1986

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z.	ARMANDO STARCEVIC B.	ING. ARMANDO [illegible]

CUADRO N° 4-A | REPORTE N° 11



DIA	HORA	FECHA	MES	AÑO
JUEVES	18:00	22	OCTUBRE	1987

EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMIC				
TOTAL		100.00	594.8	100.00

EMPRESAS	GENERACION		FACTOR DE CARGA
	K W H	%	
MENORES			
CNFL-HIDRO			
ICE - HIDRO			
ICE -TERMIC.			
TOTAL	9 710 000	100.00	68.02

OBSERVACIONES:

I.C.E.	DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
	DPTO. CONTROL DE ENERGIA-OFICINA ESTADISTICA

MES: OCTUBRE

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z	ARMANDO STARCEVIC B.	ING. ARMANDO BALMA

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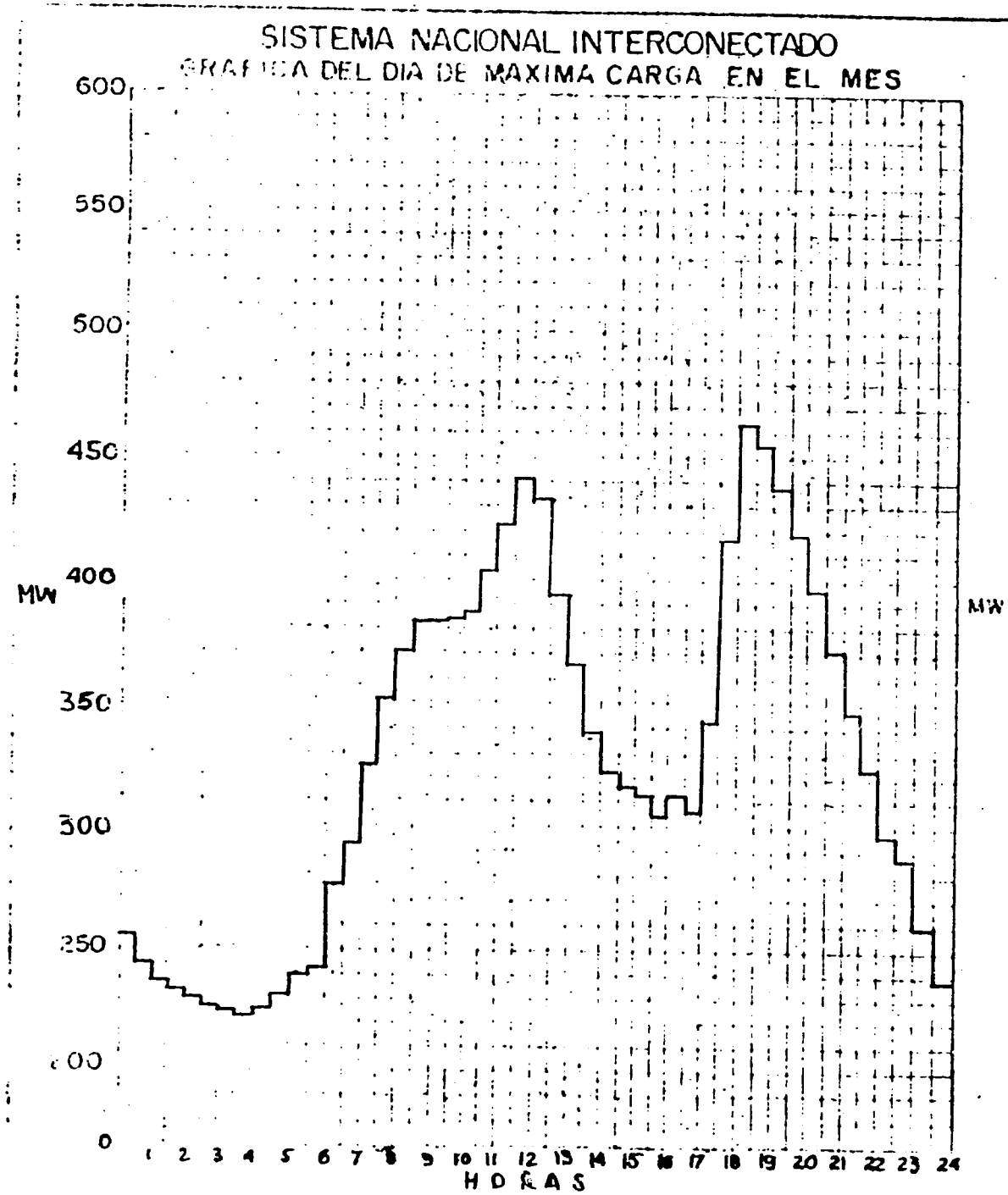


DIA	HORA	FECHA	MES	AÑO
DOMINGO	18:00	25	OCTUBRE	1987

EMPRESAS	CAPACIDAD		CARGA MAXIMA	
	K V A	%	M W	%
MENORES				
CNFL-HIDRO				
ICE - HIDRO				
ICE -TERMIC				
TOTAL		100.00	464.6	100.00

EMPRESAS	GENERACION		FACTOR DE CARGA
	K W H	%	
MENORES			
CNFL-HIDRO			
ICE - HIDRO			
ICE -TERMIC			
TOTAL	7 790 900	100.00	69,87

OBSERVACIONES:

I.C.E. DIRECCION PRODUCCION Y TRANSPORTE DE ENERGIA
DPTO. CONTROL DE ENERGIA-OFICINA ESTADISTICA

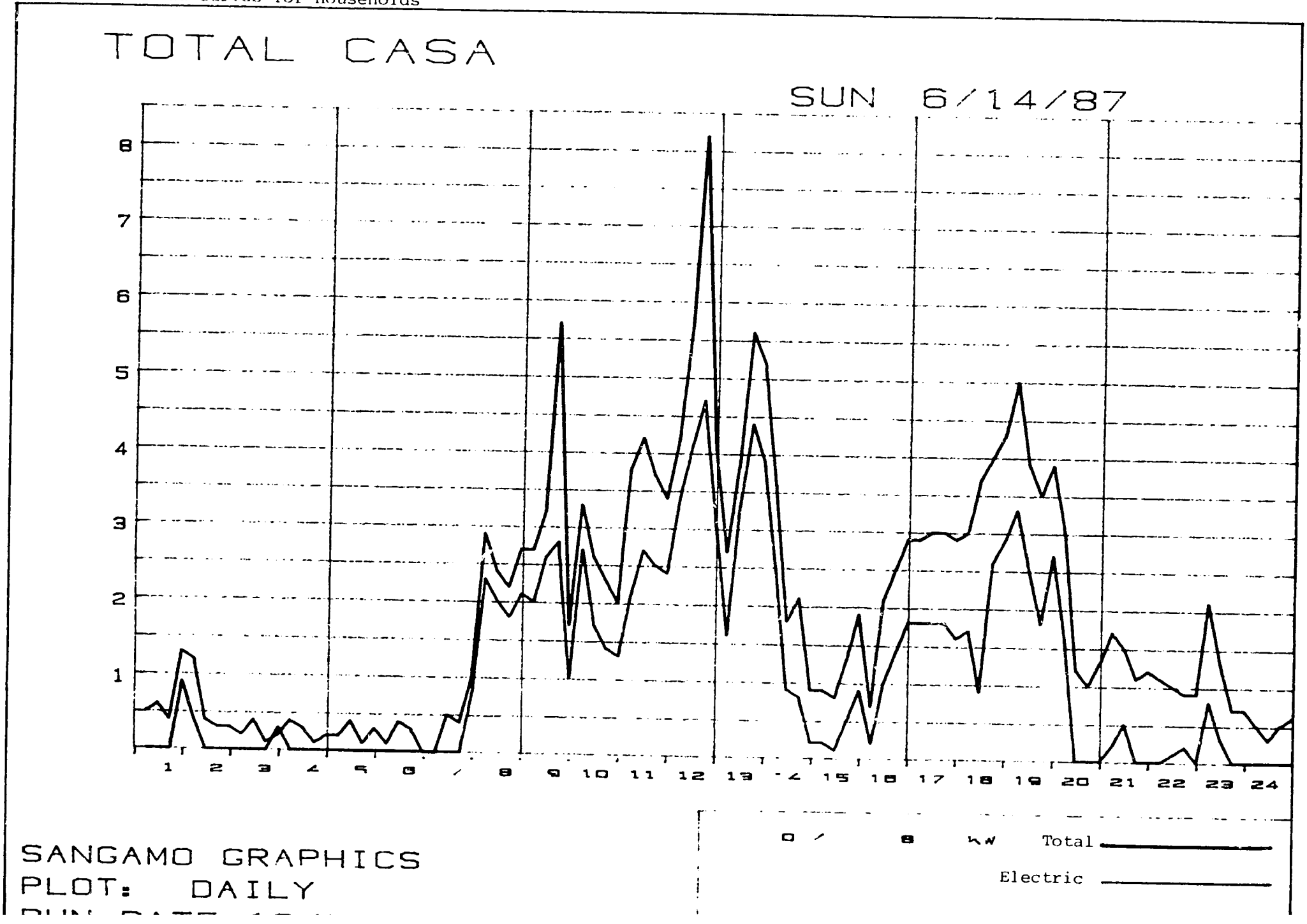
MES : OCTUBRE

DIBUJO	REVISO	APROBO
CARLOS A. ARAYA Z	ARMANDO STARCEVIC B.	ING. ARMANDO PALMA

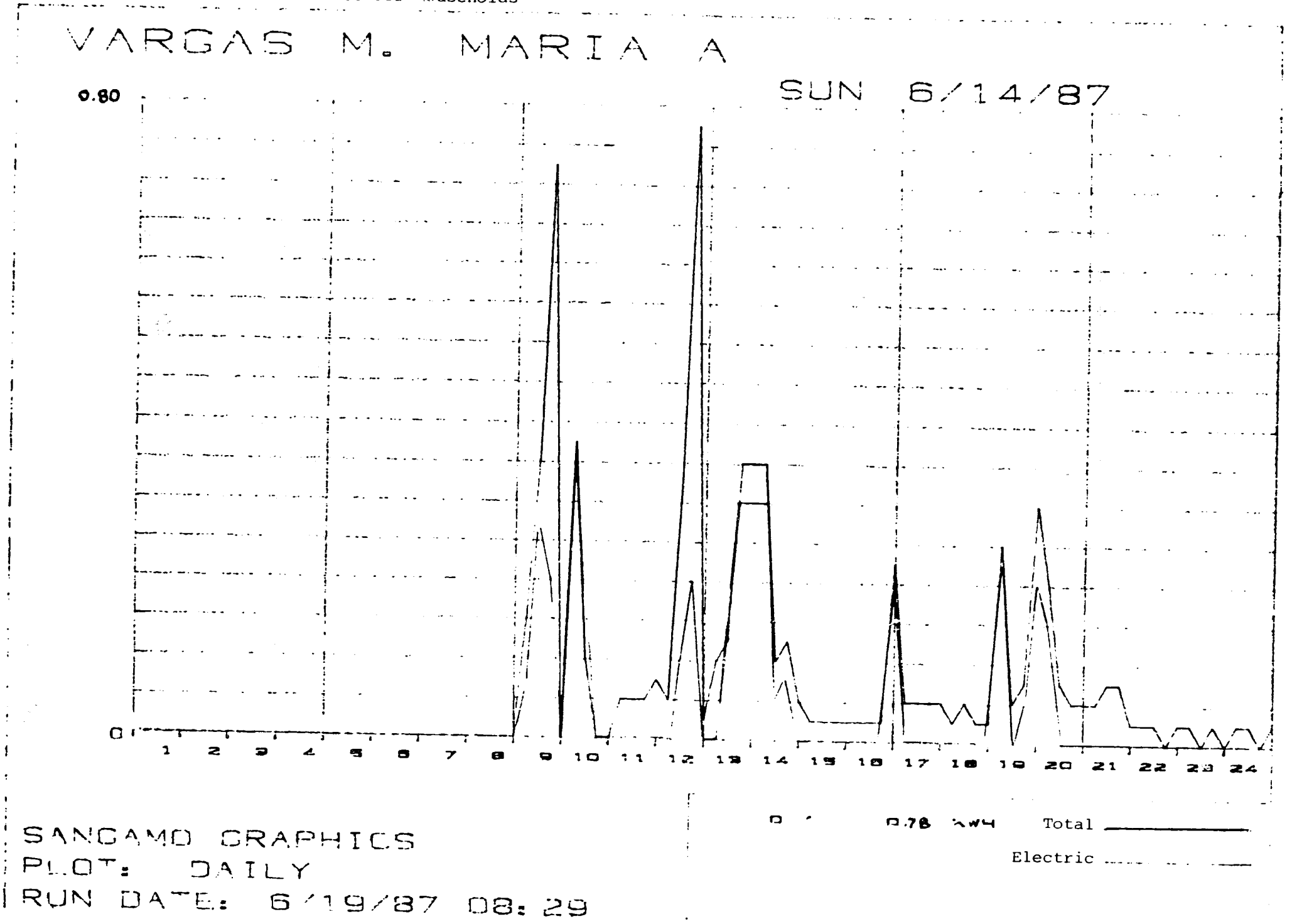
CUADRO N° 4-A REPORTE N° 10

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

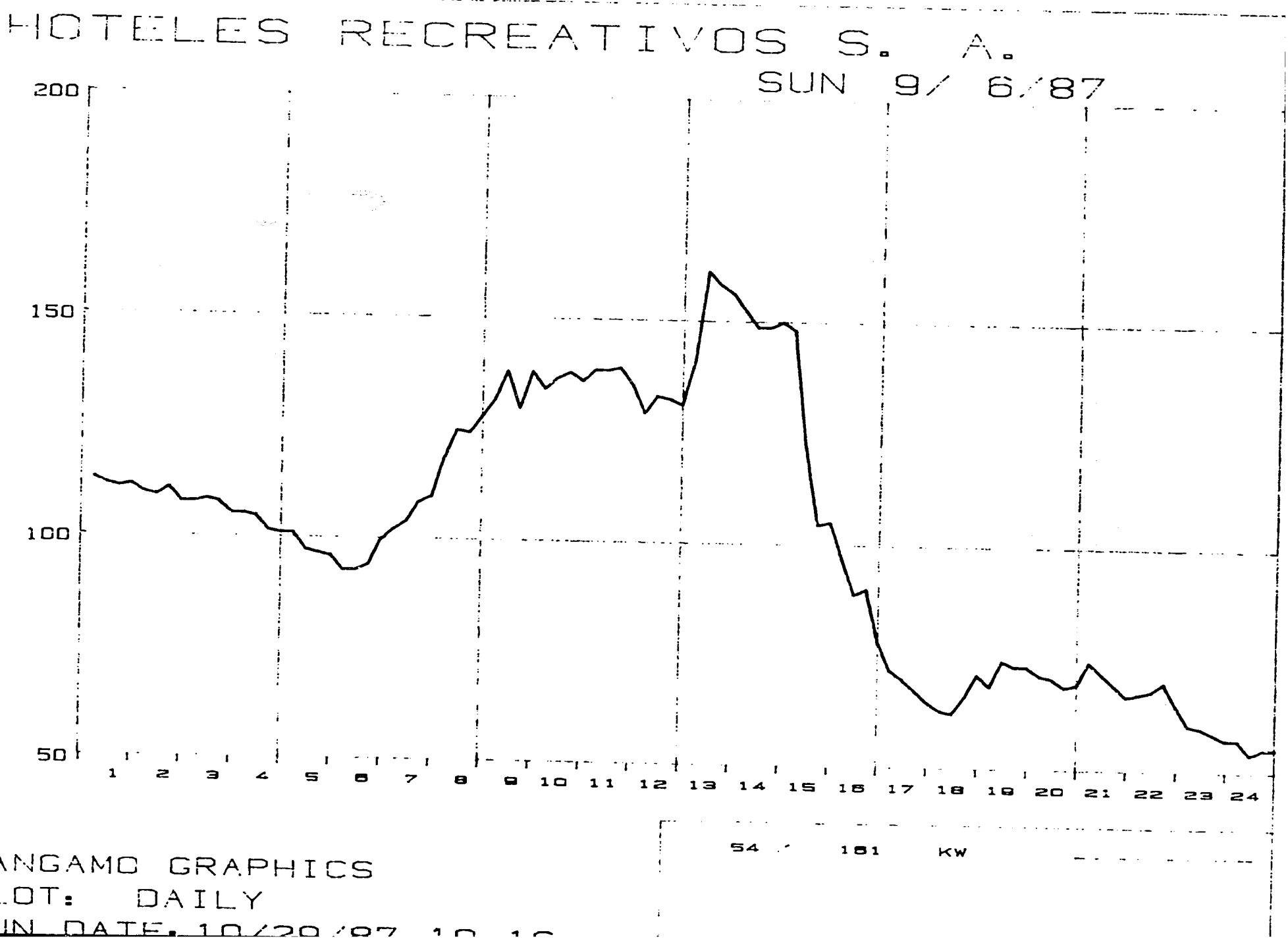
Annex A1.9 Load Curves for Households



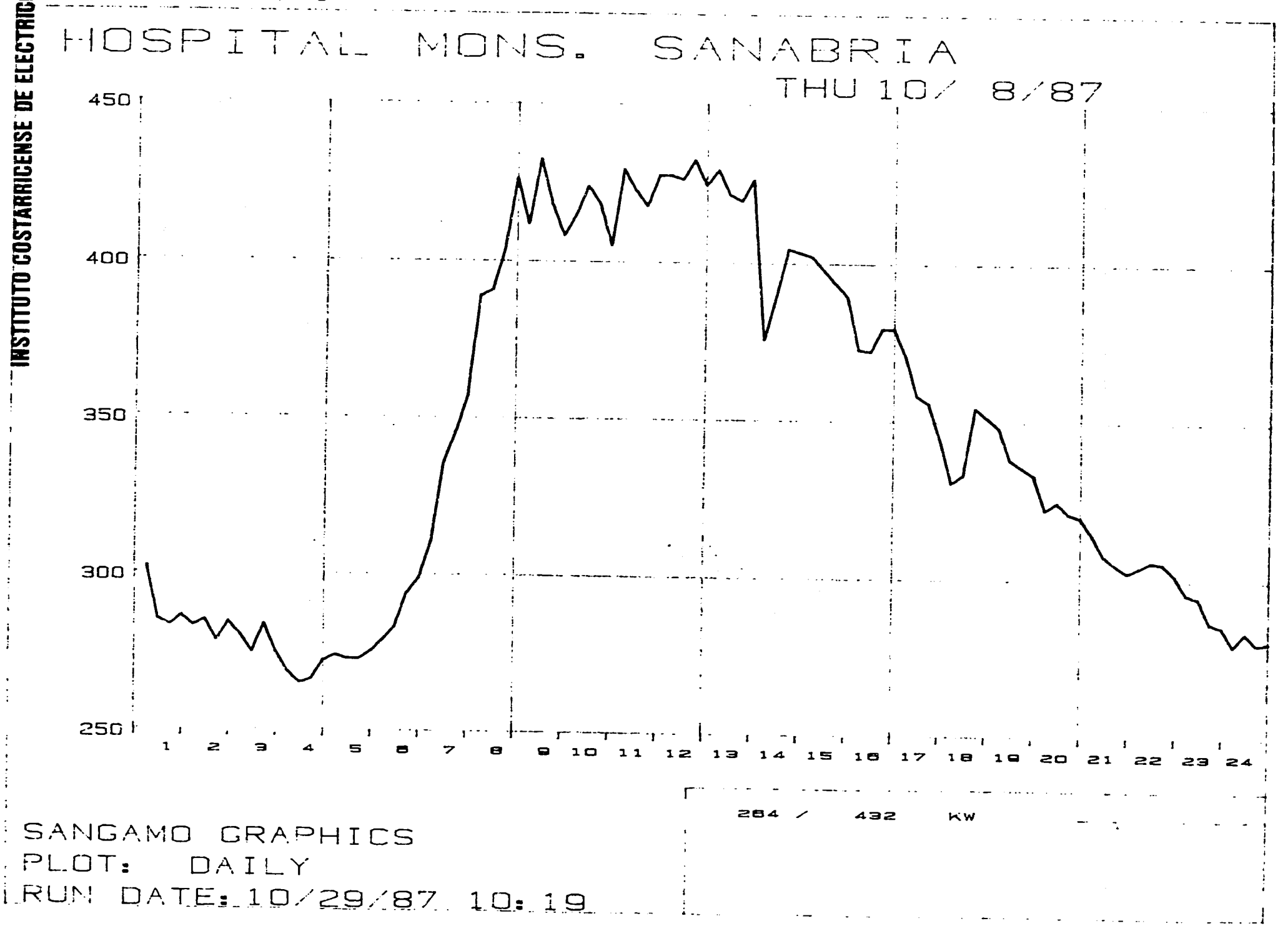
INSTITUTO COSTARRICENSE DE ELECTRIC



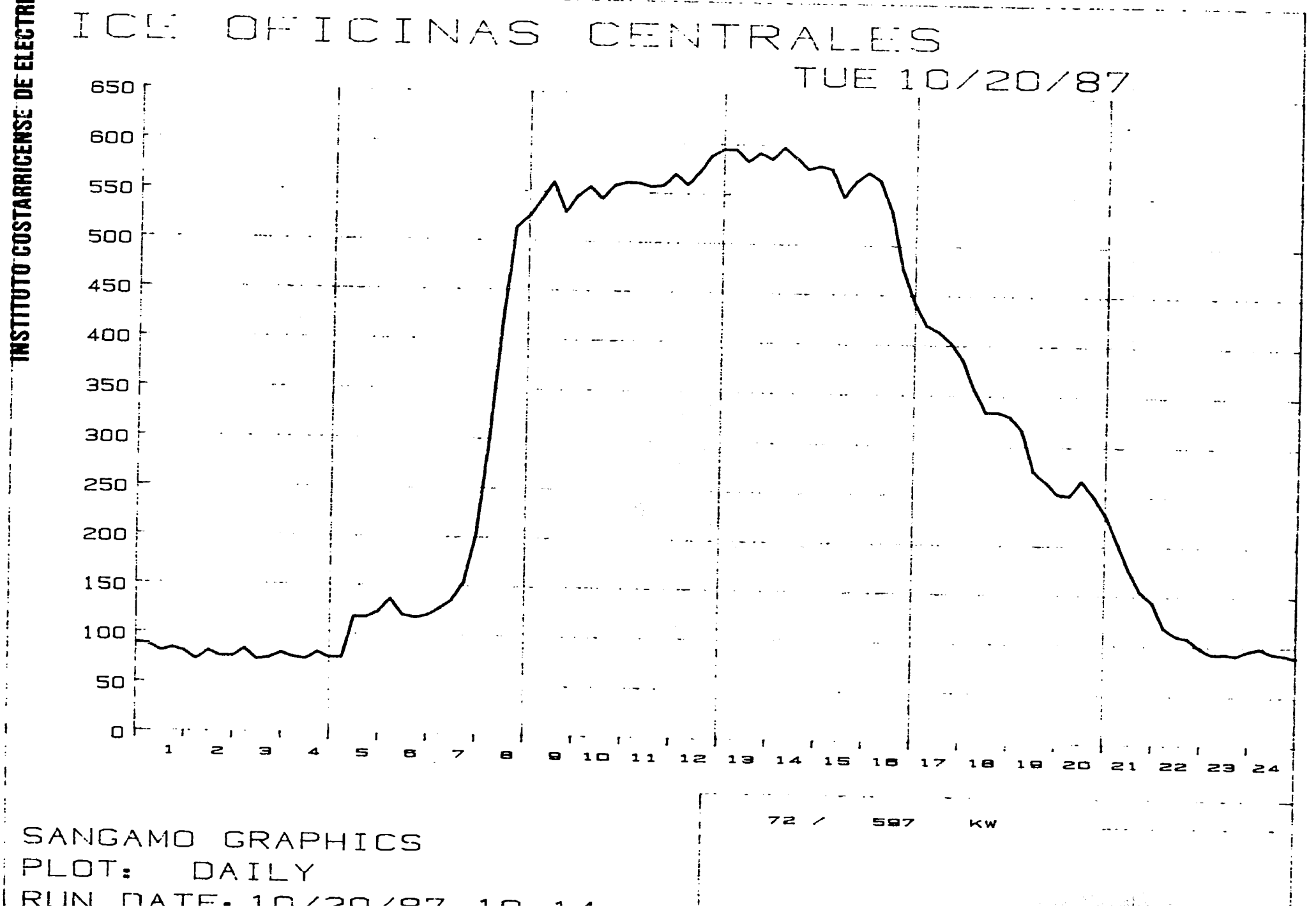
Annex A1.10 Load Curves for Selected Industries

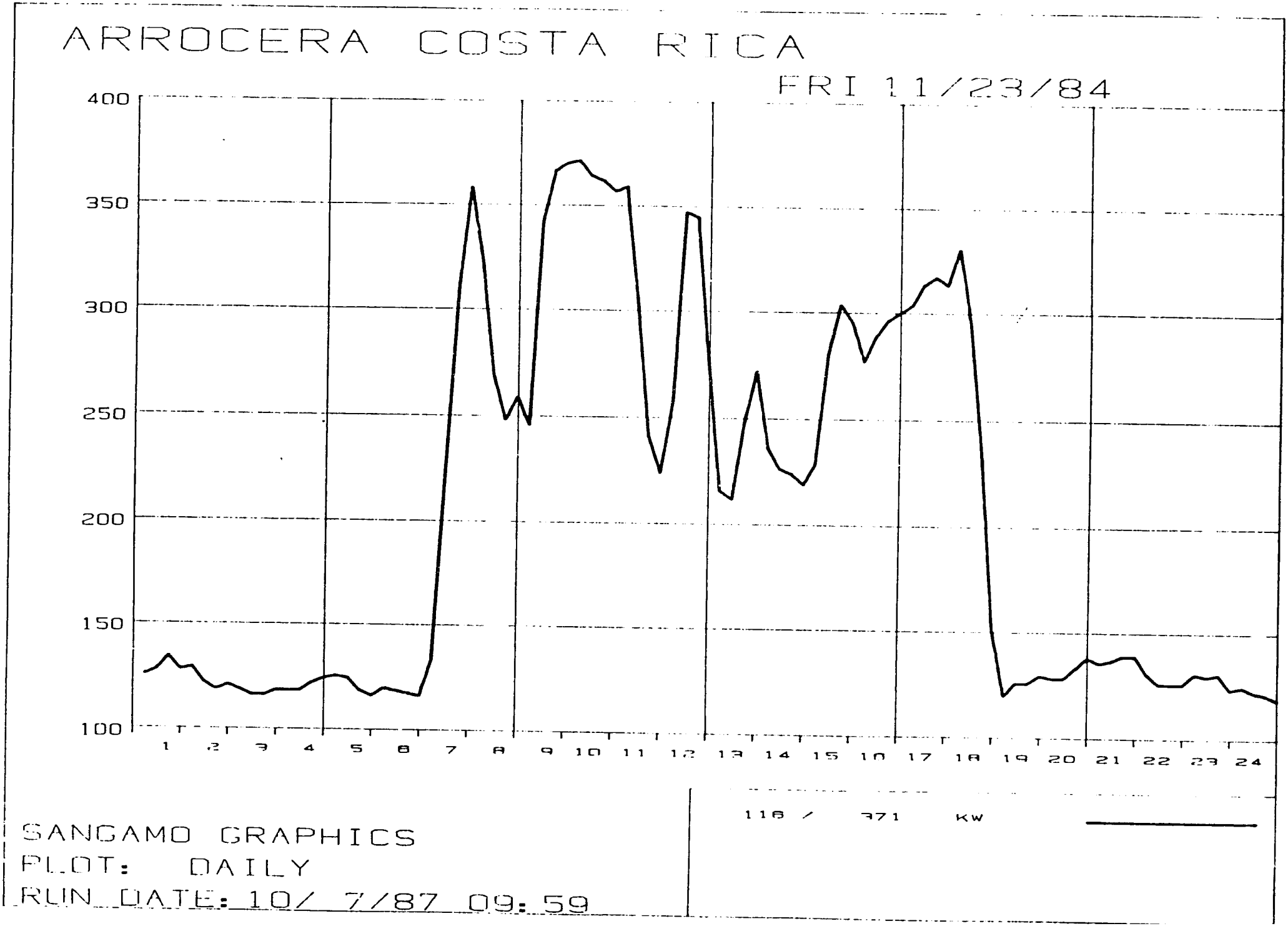


INSTITUTO COSTARRICENSE DE ELECTRICID



INSTITUTO COSTARRICENSE DE ELECTRICIDAD




ARROCERA COSTA RICA
FRI 11/23/84
400
350
300
250
200
150
100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
118 / 371 KW
SANGAMO GRAPHICS
PLOT: DAILY
RUN DATE: 10/ 7/87 09:59

#09

Annex 1-11

Large Customers of ICE

Customer/Category	Billing Demand (kW)
Bombas de Agua	
ICAA Bajo Barrantes	398
ICAA Escazu	2,500
ICAA Puente Mulas	2,250
ICAA La Bomba Limon	305
Agricola Superior	200
Inversiones Goda	100
Tractores de la Pampa	305
Empacadoras	
Cartado Beef Packing	855
CIA. Exportadora de Mariscos	52
Empacadora Carnes Costa Rica	1,038
CNP Montecillos	640
Codasa*	385
Frigorificos de Puntarenas*	430
Hospitales	
San Isidro	175
Tony Facio	415
Allen	135
Monsenor Sanabria	450
Aserraderos	
Marcos Vargas*	200
Refinadoras Aceite	
CBCR - Palo Seco*	335
Refinadoras Petroleo	
Recope	1310
Muelles	
Japdeva	229
Japdeva - Muelle Aleman	350
INCOP Caldera	589
SFC - Containers	1,240

* Denotes customer on TOU tariff, T8.

Annex 1- 1 (continued)

Large Customers of ICE

Customer/Category	Billing Demand (kW)
Arroceras	
CNP Barranca	392
Arrocera Costa Rica*	320
Los Sauces*	260
Nortena*	140
Liborio*	480
Montes de Oro*	300
Morlinos del Guanacaste*	245
Arroz del Ceibo*	190
Molinos	
Molinos de Costa Rica	1,600
Hoteles	
La Costa*	425
Magda*	110
Hoteles Recreativos*	195
Ingenios	
HDA. La Luisa	415
Taboga	1,200
Atirro	200
Coopevictoria*	780
Coopeagri*	205
Fabricas de Hielo	
Fab. Hielo Gutierrez*	180
Proc. Yuca Irrica*	110
Procesos Frutas	
El Angel*	1,260
Frutas del Pacifico*	340
Fabricas Fertilizantes	
Fertica*	5,200
Fabricas de Vidrio	
Vicesa*	2,800

* Denotes customer on TOU tariff, T8.

Annex 1-11 (continued)

Large Customers of ICE

Customer/Category	Billing Demand (kW)
Fabricas de Ladrillo	
Ladrillera Industrial*	320
Fabricas de Jabon	
Punto Rojo*	450
Fabricas de Licores	
CNP Grecia*	550
Fabricas de Cemento	
INCSA*	9,450
CEMPA	8,750
CIA. Agric. Comercial Azul*	160
Fabricas Cables	
Conducen*	1,000
Fabricas de Llantas	
Industrias Firestone*	2,200
Fabricas Asbesto Cemento	
Ricalit	740
Fabricas de Sacos	
Rafia	295
Fabricas de Cajas Carton	
Envaco	325
Fabricas de Corcholatas	
Crown Cork	545
Fabricas de Textiles	
Ticatex*	2,350
Olympic Fibers	2,440

* Denotes customer on TOU tariff, T8.

Annex 1-11 (continued)

Large Customers of ICE

Customer/Category	Billing Demand (kW)
Beneficios	
Atirro	250
Coopesabalito*	110
La Mesta*	585
Santa Rosa*	110
La Eva*	385
El Aguila	240
Coop. Cafic. Naranjo*	700
Coop. Cafic. Atenas*	300
Cafetalera Pilas*	400
Coop. Cafic. Palmares*	400
Meseta San Pablo*	2,050
San Juanillio*	595
CIA. Cafet. De Turrialba*	215
Trojas*	200
Coop. Victoria*	710
Cais*	305
Coopebuena*	230
Cooprosanvito*	365
Paso Real*	230
Coopecafira*	620

* Denotes customer on TOU tariff, T8.

Annex 1.12

Large Customers of CNFL: Tariffs 2 & 3

	Customer	kW	kWh	LF (%)	# Hrs.
1 .	Hotel Costa Rica	117	72,078	84.4	617
2 .	Ladrillera Sabana LTDA	136	62,983	63.4	65
3 .	Hospital San Juan De Dio	--	129,200	-	-
4 .	JTA Protecc Social Sn Jo.	123	16,200	18.0	132
5 .	Asilo Chapui	--	78,800	-	8,800
6 .	Rodolfo Robles Guzman	92	14,361	21.4	157
7 .	Industria Nacional De Ca	147	12,729	11.9	87
8 .	Fab-De Tejidus Los-Leone	111	18,278	22.6	165
		37	10,367	39.1	286
9 .	Botica Francesa S.A.	101	19,992	27.1	198
10 .	Auto Mercantil LTDA	94	15,340	22.4	164
11 .	SNAA	228	11,424	6.9	51
12 .	Beneficiadora Romo S.A.	122	8,568	1.4	71
13 .	Alimentos Ligeros C.A.S.	105	17,462	22.8	167
14 .	Wolf Leib Rudelman	119	18,604	21.4	157
15 .	Plastiply SA	250	11,750	6.4	47
16 .	E.F. Hehl De Costa Rica	151	6,400	5.8	43
17 .	Castro Aviles Fernando	107	13,137	16.8	123
18 .	Sur Quimica S.A.	103	11,424	15.2	111
19 .	Siemens De-C-A. C.R.-LTDA	102	14,035	18.8	138
20 .	Industrias Midamerica S	104	9,628	12.7	93
21 .	Rosago SA	126	18,768	20.4	149
22 .	Federac Coop Cafic RL	129	17,462	18.5	136
23 .	Carrocera Centro American	141	18,931	18.4	135
24 .	Patisand LTDA	98	13,872	19.4	142
25 .	Laborat Quimicos Ind - S.A.	116	18,400	21.7	159
26 .	Neon Nieto S.A.	114	15,504	18.6	136
27 .	Subproductos de Cafe SA	118	4,243	2.8	36
28 .	Agricola Commercial El PA	113	11,260	13.7	100
29 .	Quebrador Santor Rosa S	113	13,708	16.6	122
30 .	Sociedad Aserradero Lara	119	16,401	18.9	138
31 .	Minist Obras Publ Y Tran	79	3,427	5.9	44
		144	8,812	8.4	62
		194	2,937	2.1	16
32 .	Concre Tico SA	100	13,464	18.4	135
33 .	Fabrica Oxigeno Miller H	96	3,672	5.2	39
34 .	Quebradores Unidos SA	106	12,321	15.9	117
35 .	Care Costa Rica	176	--	-	0.0
36 .	Universidad de Costa Rica	121	41,983	47.5	347
37 .	ICIENSA	131	29,539	30.9	226
		4,683			

TARIFA-4 MAS DE 20000 KWH

LOCALIDAD	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	DIAS USO	T-S
[illegible]	[redacted]							
[illegible]	I [redacted] BESARR	900662	[redacted]	[redacted]	123,324.75	3.3952	[illegible]	[illegible]
[illegible]	BANCO CENTRAL PLAZA CULT	909171	[redacted]	[redacted]	637,175.75	3.6873	[illegible]	[illegible]
[illegible]	HOTEL PRESIDENT	906486	[redacted]	38,480	154,009.25	4.2217	[illegible]	[illegible]
[illegible]	BANCO ANGLO COSTARRICENS	905957	70	23,200	73,509.75	3.3840	[illegible]	[illegible]
[illegible]	[redacted] METROPOLI	906946	[redacted]	[redacted]	222,176.50	3.9120	[illegible]	[illegible]
[illegible]	[redacted] COST DE-SEGURO SOCI	906480	[redacted]	[redacted]	117,781.25	3.5905	[illegible]	[illegible]
[illegible]	C[redacted]S S	910599	[redacted]	[redacted]	233,117.75	3.8766	[illegible]	[illegible]
[illegible]	CONTRALORIA GRAL REPUBLI	908271	[redacted]	[redacted]	235,743.75	3.0540	[illegible]	[illegible]
[illegible]	CLINICA BIBLICA	910568	85	22,521	86,134.75	3.8246	[illegible]	[illegible]
[illegible]	MAS X MENOS	910280	90	36,148	115,274.75	3.1839	[illegible]	[illegible]
[illegible]	OFICINA DEL CAFE	906763	51	24,969	74,406.25	2.9799	[illegible]	[illegible]
[illegible]	CARLOS FEDERSPIEL Y CIA	909806	91	20,114	85,084.75	4.2301	[illegible]	[illegible]
[illegible]	PROPIEDADES METROPOLI S.	906188	86	20,971	83,754.00	3.9938	[illegible]	[illegible]
[illegible]	LA GRAN VIA S A	901250	82	27,091	93,133.25	3.4374	[illegible]	[illegible]
[illegible]	LEHMANN LIM-IMP-Y LET-LT	906078	77	30,355	96,414.00	3.1762	[illegible]	[illegible]
[illegible]	RODFON S A	938014	80	20,196	78,694.50	3.8965	[illegible]	[illegible]
[illegible]	HOTEL ORIENTAL	924017	98	22,113	97,089.50	4.2097	[illegible]	[illegible]
[illegible]	ELADIO TREJOS FLORES	908477	133	55,814	154,476.25	2.7676	[illegible]	[illegible]
[illegible]	ELADIO TREJOS FLORES	000000	13	4,547	15,237.50	3.3511	[illegible]	[illegible]
[illegible]	ELADIO TREJOS FLORES	000000	52CR	131,[illegible]CR	376,032.50CR	2.0674	[illegible]	[illegible]
[illegible]	CENTRO COMERCIAL S.A.	907[illegible]	52	181,[illegible]	376,032.50	2.0674	[illegible]	[illegible]
[illegible]	PODER LEGISLATIVO	924[illegible]	49	22,072	63,139.50	3.0866	[illegible]	[illegible]
[illegible]	ADOLCRI SOCIEDAD ANONIMA	906465	171	34,384	161,063.25	4.6171	[illegible]	[illegible]
[illegible]	EMBAJADA AMERICANA	924004	66	22,317	74,671.50	3.3459	[illegible]	[illegible]
[illegible]	HOTEL AMSTEL	909172	201	77,601	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	HOTEL AMSTEL	000000	94CR	33,619CR	112,[illegible]CR	3.3525	[illegible]	[illegible]
[illegible]	HOTEL AMSTEL	000000	94	33,619	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	RADIOGRAFICA COSTARRIC S	909200	94	33,619	112,[illegible]	3.3552	[illegible]	[illegible]
[illegible]	ASOC [illegible]OLA DE BENEFIC	901269	283	132,[illegible]	474,486.50	3.4224	[illegible]	[illegible]
[illegible]	INMOVILIARIA ALONSO	905008	69	21,705	73,344.00	3.4574	[illegible]	[illegible]
[illegible]	CIA NUMAR S.A	909732	36	32,150	105,217.75	3.2727	[illegible]	[illegible]
[illegible]	LANDMARK S A	910312	260	39,841	119,557.75	3.5569	[illegible]	[illegible]
[illegible]	FABRICA NACIONAL DE-LICO	910552	444	210,880	564,284.50	2.6753	[illegible]	[illegible]
[illegible]	MINIST CULT JUVENT Y DEP	901175	106	23,337	87,714.00	3.7585	[illegible]	[illegible]
[illegible]	INSTITUTO NACIONAL SEGUR	905691	79	22,766	83,033.50	3.6472	[illegible]	[illegible]
[illegible]	INST NAL VIVIENDA Y-URB	903478	696	73,200	547,136.25	7.4745	[illegible]	[illegible]
[illegible]	FABRICA DE HIELO	906347	139	28,070	123,932.25	4.5933	[illegible]	[illegible]
[illegible]	CAJA COST SEGURO SOCIAL	905328	79	42,268	105,260.75	2.4903	[illegible]	[illegible]
[illegible]	CAJA DEL SEGURO SOCIAL	903929	366	181,200	553,063.75	3.0798	[illegible]	[illegible]
50[illegible]101560	MAS X MENOS	906334	168	57,600	202,892.25	3.5224	[illegible]	[illegible]
50[illegible]200360	LYDA TUFI DE-FEOLI	910231	51	29,336	81,926.75	2.8363	[illegible]	[illegible]
50[illegible]500300	PURDY MOTOR -	906420	150	56,467	190,002.25	3.3643	[illegible]	[illegible]
50[illegible]700940	CENTRO COLON S A	907030	162	51,408	187,432.00	3.6459	[illegible]	[illegible]
50[illegible]400500	COLGATE PALMOLIVE DE CR	907573	89	42,595	127,057.75	2.9829	[illegible]	[illegible]
50[illegible]900830	YAOHAN CENTROAMERICANA S	906910	97	25,195	76,341.00	3.4325	[illegible]	[illegible]
50[illegible]103500	I C E	912003	97	47,840	141,890.25	2.9659	[illegible]	[illegible]
50[illegible]001880	CONFECCIONES SIGLO S A	909169	73	27,907	92,332.75	3.2010	[illegible]	[illegible]
50[illegible]500100	HITO RINCON S A	909071	147	34,598	126,682.00	3.6615	[illegible]	[illegible]
50[illegible]001000	I C E	924121	296	121,120	601,563.75	4.9666	[illegible]	[illegible]
50[illegible]002260	AGENCIA DATSUN	905054	196	45,043	195,449.75	4.3391	[illegible]	[illegible]
50[illegible]200100	I C E	912003	137	34,108	139,334.75	4.0851	[illegible]	[illegible]
50[illegible]201050	I C E	909152	123	55,040	170,595.50	3.0994	[illegible]	[illegible]
50[illegible]201520	I.C.E. -	910543	73	42,328	119,305.50	2.8371	[illegible]	[illegible]
		907563	672	170,400	719,474.25	4.2233	[illegible]	[illegible]

[illegible]

TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	JU T-S
0610000120	TELETICA CANAL 7	905517	133	31,089	131,157.25	4.2187	[illegible]	2
0700300420	BANCO DE COSTA RICA	906066	564	184,800	651,882.25	3.5275	[illegible]	2
0700600140	MINISTERIO DE HACIENDA	907270	51	26,846	73,010.00	2.9053	[illegible]	2
0700800020	CAJA COSTARRICENSE DE S.	908173	57	21,358	69,615.75	3.2594	[illegible]	2
0700300100	JTA PROT SOCIAL SAN-JOSE	906349	98	44,064	135,235.50	3.0690	[illegible]	2
0700300360	HOSPITAL NACIONAL DE-NI/	908481	394	186,240	584,407.50	3.1379	[illegible]	2
0700800420	JUNTA PROTECCION SOCIAL	906473	105	21,379	95,847.00	4.4832	[illegible]	2
0700801040	CAJA COST DE SEGURO SOCI	906942	97	30,844	109,258.00	3.5422	[illegible]	2
0700801340	MINIST SALUBRIDAD PUBLI	910700	123	27,662	118,625.00	4.2883	[illegible]	2
0702100600	BCO CRED AGRICOLA CARTAG	906643	121	28,723	119,471.50	4.1594	[illegible]	2
0702100620	BCO CRED AGRICOLA CARTAG	907572	114	27,744	113,425.25	4.0832	[illegible]	2
0702201000	MORRASE HNOS	901412	77	24,160	74,563.75	3.0262	[illegible]	2
0[illegible]2700060	SECCION CERVECERIA ORTEG	905998	107	26,846	107,534.25	4.0055	[illegible]	2
0[illegible]2800060	CARLOS FEDERSPIEL Y CO S	901136	121	22,358	93,603.25	4.1867	[illegible]	2
0710070212	COMPANIA NUMAR SA	000000	957	579,406	1375,524.75	2.3740	[illegible]	2
0801100100	PODER JUDICIAL	910594	296	77,600	317,484.25	4.0912	[illegible]	2
0801200300	PODER JUDICIAL	908474	312	97,200	364,640.25	3.7514	[illegible]	2
0801300100	PODER JUDICIAL	910084	90	23,664	91,305.50	3.8584	[illegible]	2
0901600020	CLINICA SANTA RITA	910287	86	22,684	87,043.00	3.8371	[illegible]	2
0804501000	COOP DE PRODUC DE LECHE	906941	112	56,800	145,593.25	2.5632	[illegible]	2
0804501060	COOP DE PROD DE LECHE R	910591	256	139,400	357,057.25	2.5325	[illegible]	2
0804501061	COOP DE PROD DE LECHE R	910256			2,624.50	2624.5000		
0804501120	COOP DE LECHE DOS PINOS	909182	252	102,816	291,059.50	2.8303	[illegible]	2
0804501240	COOP PROD LECHE DOS PINO	910600	292	141,800	374,993.25	2.6445	[illegible]	2
0804501300	COOP PROD LECHE DOS PINO	905984	81	31,660	83,363.75	2.6363	[illegible]	2
0804501365	COOP PRODUCT LECHE DOS P	908466	816	385,200	1036,169.25	2.6899	[illegible]	2
0804501260	COOPERATIVA PROD LECHE R	905025	79	22,440	77,850.50	3.4356	[illegible]	2
1000000080	MINIST OBRAS PUBL Y TRAN	906069	173	38,841	169,851.00	4.3729	[illegible]	2
1000000170	E Y M GOICOECHEA S A	906614	144	34,273	124,647.25	3.6369	[illegible]	2
1000104220	PERIFERICOS DEL SUR	924122	93	35,360	115,547.50	3.2677	[illegible]	2
1100015[illegible]30	INST-MATER INF-CARIT	906659	53	24,847	74,336.25	3.0133	[illegible]	2
1100100200	INST COST FERROCARRILES	906633	143	27,254	132,722.75	4.8693	[illegible]	2
1100400[illegible]	VITEMCA SA	908047	120	45,124	186,081.25	4.1237	[illegible]	2
1100[illegible]1000	MINISTERIO DE JUSTICIA	908487	147	36,720	150,302.25	4.0931	[illegible]	2
1302100310	MUEBLERIA URGELLES Y PEN	000000	112	40,206	115,270.00	2.8669	[illegible]	2
1302201160	AMERICAN ICE CREAM	900402	78	25,785	77,728.75	3.0144	[illegible]	2
1400[illegible]100	COMPAYIA NUMAR S.A	910572	312	90,000	300,041.25	3.3337	[illegible]	2
1[illegible]0500570	COOP MATADERO MONTECILLO	938010	135	64,790	292,795.25	4.5191	[illegible]	2
1400501100	INDUSTRIA NACIONAL DE CA	910014	156	43,574	168,819.25	3.8743	[illegible]	2
1400501100	INDUSTRIA NAL DE CALZADO	000000	156CR	43,574CR	168,819.25CR	3.8743	[illegible]	2
1400501100	INDUSTRIA NAL DE CALZADO	000000	156	43,574	95,540.25	2.1925	[illegible]	2
1400502120	INDUSTRIAS MIL COLORES	909066	174	48,348	162,732.00	3.3659	[illegible]	2
1400600200	HILATEX S A	938043	126	20,155	92,495.50	4.5892	[illegible]	2
1400600230	YAMSER S A	909173	924	429,600	1162,985.25	2.7071	[illegible]	2
1400600241	ALFOMBRAS C AMER S.A.	909855		6,380.00	6389.0000			
1400700130	SHALON S A	909187	71	38,183	161,822.75	4.2375		2
1400700501	FABRICA DE PISOS S.A.	910299			2,437.50	2437.5000		
1400901140	CONSEJO NAC-DE PRODUCCIO	909713	137	95,227	286,445.75	3.0080	[illegible]	2
1401120325	MC DONALD S A	910702	72	27,542	83,933.00	3.1965		2
1402700020	SOC EMPACADORA COST-LTDA	905959	100	37,600	103,105.25	2.3751	[illegible]	2
1500200640	INDUSTRIAS DOYCO-S.A.	906766	131	38,183	124,569.50	3.2620	[illegible]	2
1503101130	QUIROS Y COMPANIA	000000	258	72,600	223,907.25	3.1559	[illegible]	4
1600150095	BANCO AGRO IND Y DE EXP	910576	102	32,552	173,287.50	5.3224	[illegible]	2
1600200040	BANCO CENTRAL DE-C.R.	908923	413	120,000	468,536.50	3.9044	[illegible]	2

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TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	T-S
1600300920	COSTA-RICA FAST-FOOD SER	910296	84	33,864	107,313.00	3.1690	404	2
1600900280	MINISTERIO DE HACIENDA	908473	221	51,520	222,766.75	4.3233	[illegible]	2
1600900731	MINISTERIO DE HACIENDA	908326			3,114.25	3114.2500		2
1601400140	BCO NAL DE COSTA RICA	910575	762	270,000	964,278.75	3.5714	[illegible]	2
1601400180	BANCO NAC-DE COSTA-RICA	910879	220	62,832	243,890.50	3.8816	[illegible]	2
1601400220	DIRECCION DE COMUNICACIO	901584	72	23,827	80,204.00	3.3954	331	2
1602400920	SOTO CHAVES HECTOR	948045	105	20,726	94,593.25	4.5639	193	2
1300103940	SOCIEDAD MINIMAX S.A	906903	65	29,294	87,710.00	2.9941	451	2
1300450260	CLINICA CAT-LA PURISIMA	909493	66	22,195	74,437.25	3.3537	337	2
1800700240	EL GALLITO INDUSTRIAL LT	000000	709	233,624	752,500.75	3.1353	330	2
1800773160	CONOPLAST S A	906538	432	225,600	582,425.25	2.5816	[illegible]	3
1801320260	CALZADO DAISY S A	924039	126	40,147	125,282.25	3.1205	[illegible]	3
1801327160	DURMAN ESQUIVEL	910551	612	270,000	745,241.25	2.7601	442	6
1801327420	EL DORADO LTDA	906476	167	47,001	157,023.00	3.3403	[illegible]	3
1802322060	EMBOTELLADORA TICA S.A.	909080	144	26,112	111,265.00	4.2610	182	3
1802335340	EMBOTELLADORA TICA LTDA	924125	573	190,050	597,123.25	3.1419	[illegible]	3
1802435340	TEXPORT CENTROAMERICANA	938037	61	27,744	83,305.50	3.0026	455	3
1802431640	TEXTILES NYLON DE C RICA	906626	253	95,472	279,515.25	2.9277	[illegible]	3
1802420320	MOTOROLA DE CENTROAMERIC	909075	407	183,045	500,126.75	2.7323	450	3
1802565040	RECOPE	909153	133	37,692	148,324.75	3.8046	274	3
1802662340	CONCRETO ASFALTICO S.A	909714	144	26,601	113,067.00	4.2123	[illegible]	3
1802731500	BANDECO S A	910693	169	41,458	172,483.25	4.1610	246	3
1802790200	HOTEL AMSTEL S A	906202	144	56,145	192,510.75	3.4591	[illegible]	3
1802790930	LA REPUBLICA	908463	51	20,565	65,946.50	3.2070	4[illegible]	4
1803420100	CONSERVAS DEL CAMPO LTDA	909721	96	23,745	83,383.00	3.5116	242	3
1803420150	CARLOS L ODIO S A	909202	336	79,300	293,313.25	3.7006	[illegible]	3
1803420240	DEL CAMPO ALIMENTOS CONG	908232	182	60,710	187,005.75	3.0803	[illegible]	3
1804120430	YOLANDA DE COSTA RICA S.	906466	134	31,008	114,294.25	3.6859	[illegible]	3
1804450340	LOS PERIFERICOS S A	907550	47	22,320	67,891.50	3.0417	475	3
1804460430	ARCOS DE ORO DE GUADALUP	907264	70	23,990	80,026.50	3.3358	442	3
1805590525	BOTICA FRANCESA S A	924071	76	26,240	87,918.00	3.3505	442	3
1807600260	S N A A	906867	131	31,334	130,437.25	4.1623	[illegible]	3
1809465700	HILAFIASA	903918	456	188,400	533,417.25	2.8313	414	3
1810002200	LONA TICA LTDA	910539	224	72,787	227,812.00	3.1298	[illegible]	3
1815665701	ASERRADERO QUIROS COTO	906931			6,718.00	6718.0000		3
1901201130	MINISTER EDUCACION PUBLI	907704	66	21,052	72,242.50	3.4316	[illegible]	3
1901602500	RADIO MONUMENTAL	924038	67	41,371	111,612.25	2.6978	[illegible]	3
2[illegible]2100000	MESALLES HNOS	909776	72	23,664	71,250.21	3.0109	[illegible]	3
2[illegible]6053000	KAJIMA CORPORATION	910936	297	47,160	393,484.14	8.3435	[illegible]	3
2096059500	KAJIMA CORPORATION	816100	73	29,608	141,429.53	4.7767	[illegible]	3
2200382380	RADIO IMPACTO S A	924002	67	32,640	94,848.31	2.9059	[illegible]	3
2402001000	I C E	908462	77	30,110	95,943.69	3.1864	[illegible]	3
2695115000	FLORES DEL CERRO S A	906775	97	22,195	86,699.40	3.9063	[illegible]	3
2800102360	S N A A	906697	65	40,310	108,146.49	2.6835	[illegible]	3
2802003520	CENADA	910082	208	43,034	198,831.39	4.6149	[illegible]	3
2806001400	JAKAMAIZAN S.A.	810013	58	21,996	71,197.93	3.2363	[illegible]	3
2806103600	PUERTAS Y VENTANAS DE C	905337	114	20,726	87,431.85	4.2184	[illegible]	3
2806103000	SERVICIO NAL DE A Y A	909783	69	29,212	59,457.50	3.0423	[illegible]	3
2806587100	UNIVERSIDAD NACIONAL	907560	106	29,131	111,326.10	3.8215	[illegible]	3
2806587480	MINIST AGRICUL Y GANADER	910549	87	24,072	90,303.19	3.7513	[illegible]	3
2810000980	VIDAL INTERNACIONAL	924067	94	23,011	81,179.37	3.5278	[illegible]	3
2810401400	INVERSIONES DECATUR S A	924050	147	22,032	106,073.78	4.8145	[illegible]	3
2810401500	PRODS TEXT MISION VIEJA	906751	141	39,494	131,711.53	3.3349	[illegible]	3
2811007100	LABORATORIOS TRAVENOL S	938007	93	26,601	96,566.03	3.2542	[illegible]	3

TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	30 JUN T-S
2811007140	PRODUCTOS PLASTICOS S A	910583	394	157,500	451,741.25	2.8631	400	3
3000040400	EXP AGROPECUARIAS S.A.	905680	73	29,702	81,652.46	2.7490	407	4
3000045700	HOTEL HERRADURA INN	907275	119	48,470	133,432.13	2.7941	4[illegible]	4
3000160420	CASA CLUB CARIARI S A	908925	82	23,990	87,169.46	3.6335	[illegible]	3
3000160460	HOTEL CARIARI S A	906437	110	35,577	126,083.53	3.5439	324	2
3000160430	HOTELERA COROBICI	905514	61	21,542	71,397.32	3.3143	354	2
3000160500	HOTELERA COROBICI S A	906487	322	135,800	444,704.75	3.2747	422	2
3001042800	SCOTT PAPER COMPANY CR	000000	4515	2555,000	6442,613.75	2.5215	566	2
3001303500	TRIMPOT ELECTRONICAS SOC	910284	165	67,972	221,020.75	3.2516	412	2
3001742020	SUC DE IGNACIO ZAMORA	909073	121	38,188	119,569.60	3.1310	316	4
3003001920	HERMANOS ZAMORA GONZALEZ	910327	276	32,960	183,495.59	5.7189	120	4
3003911080	NATIONAL CENTROAMERICANA	909501	116	23,541	106,545.99	4.5259	203	3
3[illegible]911120	NATIONAL CENTROAMERIC S	924026	121	32,232	109,301.83	3.4066	247	3
3006300940	AGUILAR Y SOLIS S A	906863	173	29,376	151,673.20	5.1633	17[illegible]	2
3008101500	CERVECERIA COSTA RICA	908469	1488	672,000	1841,883.50	2.7408	452	3
3008201000	TABACALERA COSTARRICENSE	906070	462	118,650	422,027.25	3.5569	227	3
3008223700	INDUST ALIMENTOS IDEAL S	905002	95	20,389	78,199.23	3.7435	[illegible]	3
3008224490	CENTRAL AMERICAN MEATS	000000	1230	537,000	1474,133.00	2.7451	437	2
3008461002	BENEFICIO LA RIVERA	000000	153	40,425	146,151.00	3.6153	265	2
3009301840	INCUBADORA COSTARRICENSE	910153	73	26,356	85,354.87	3.2764	342	2
3200330070	ENVASES COMERCIALES SA	000000	438	212,400	568,351.00	2.6753	4[illegible]	2
3200802220	ROMAN HERNANDEZ GONZALEZ	909210	75	40,800	100,353.20	2.4718	544	3
3200931040	TREFILERIA COLIMA	924106	557	194,250	593,511.25	3.0553	349	4
3201261020	PLYWOOD COSTARRICENSE SA	000000	306	316,200	635,901.00	2.0110	1[illegible]4	2
3201262000	PLYWOOD COSTARRICENSE	910605	714	321,650	830,865.25	2.7390	451	3
3202000200	METALES COMPAÑIA S.A	924109	285	103,680	308,976.50	2.9800	364	3
3202201022	LAMINADORA	000000	238	337,400	653,323.75	1.9365	141[illegible]	2
3400642284	COSTA RICAN COCOA PRODUC	907553	630	261,450	740,219.25	2.8312	415	3
3400642370	MAGMA S A	907547	378	142,800	419,633.25	2.9386	[illegible]	3
3400700620	JUNTA ADMINIST REGISTR N	905692	249	83,232	300,320.75	3.6092	[illegible]	3
3400700330	LACTARIA COSTARRICENSE S	906938	497	235,200	630,669.25	2.6314	474	3
3400700760	TREJOS HNOS SUC S A	909652	138	21,297	115,332.96	5.4154	155	2
3400320100	ORTUÑO DURAN CARLOS ALB	905967	99	26,160	154,419.39	5.9023	265	2
3400320600	MANUF DE SACOS Y MANTAS	906074	264	50,400	211,097.25	4.1884	191	3
3401340600	REPUBLIC TOBACCO CO	908476	399	92,400	347,477.25	3.7605	[illegible]	3
3402105200	ENVADESA	909719	114	55,161	143,905.25	2.6088	4[illegible]4	3
3402105260	POLYMER DE COSTA RICA	910688	303	122,400	348,677.35	2.8496	4[illegible]4	4
3[illegible]2204940	ACABADOS NACIONALES S A	908436	270	23,040	169,226.91	7.3449	[illegible]	3
3[illegible]2206600	FABRICA DEMASA	905980	208	96,777	259,155.50	2.6773	466	3
3402207280	FAB DE EMPUTIDOS GEFA LT	924044	143	31,375	137,658.87	4.3875	[illegible]	3
3402510440	CONFECCIONES IMPERIO S.A	924051	143	44,390	162,047.81	3.6640	311	3
3402[illegible]320	[illegible]	910047	164	33,537	135,[illegible]	4.0334	[illegible]	3
3402561330	PLASTIFORM Y AMESCO	905976	87	40,475	106,316.87	2.6268	4[illegible]	4
3402561620	RESINTECH S A	910889	257	68,666	237,553.50	3.4595	[illegible]	2
3402601000	SOCIEDAD ORO-INDUST LTDA	909185	129	26,316	104,099.46	3.9557	[illegible]4	2
3402601080	IND TERMOPLASTICA	000000	196	91,350	235,094.50	2.5735	407	2
3402601920	EMPAQUES TECNICOS S A	910522	280	153,440	388,082.75	2.5292	4[illegible]	4
3403100380	LA MILANESA S A	906457	131	21,297	96,363.21	4.5434	16[illegible]	4
3405900240	CAFE COSTA RICA	000000	274	27,091	96,604.00	3.5659	[illegible]	3
3410001520	CENTRO COMERCIAL DEL EST	910523	85	36,475	112,926.52	3.0959	[illegible]	3
3410401500	SAN JOSE IN DOOR CLUB	907276	255	81,518	300,601.50	3.6875	[illegible]	3
3411003300	AMADOR CESPEDES RICARDO	907382	98	20,389	79,699.23	3.8153	[illegible]14	3
3415000220	INVERSIONES K M K S A	910891	86	20,196	82,265.98	4.0733	[illegible]	3
3415[illegible]420	MONTIFRUTI S A	910974	49	22,032	59,786.03	2.7135	4[illegible]	3

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TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	JU T-S
3605270720	INST COST ELECTRICIDAD	912010	54	34,598	93,965.34	2.7159	641	2
3605640390	ASFATEX INDUSTRIAL S A	906756	105	20,400	82,397.35	4.0390	195	4
3606605280	ROSCH MARAHONA-Y HNOS-LT	905398	75	47,001	127,183.23	2.7059	627	2
3805200660	MAS X MENOS-DE ESCAZU	909199	61	28,720	85,179.33	2.9658	471	2
3805340100	COSTA-RICA COUNTRY CLUB	905990	151	59,840	177,073.75	3.2933	397	2
3805340800	CIA PLASTICOS-Y ALUMINIO	906911	216	53,529	192,228.75	3.5911	248	3
3806281220	SABETTO MARQUETTO MARIO	800182	48	21,757	67,167.80	3.0871	454	3
3806526440	LAMM S QUALITY MEATS S A	909216	128	39,657	144,631.65	3.6470	310	2
4003362200	TEXTESA -	910592	372	132,600	399,905.25	3.0158	357	3
4003360201	TEXTESA	910243			21,075.50	1075.5000		3
4200140300	RECAUCHAD LLANTAS Y SERV	905994	161	22,353	113,603.25	5.0813	179	3
4200140900	COCA COLA INTERAMERICAN	905683	97	33,619	114,586.00	3.4083	247	2
4200141160	DARLEEN FASHIONS S A	906459	107	26,275	93,032.25	3.5407	546	3
4200200100	MATRA LTDA	906642	225	39,168	173,176.75	4.4213	175	4
4200240220	COMERCIAL TECNICA S A	901617	97	42,350	114,395.25	2.7011	437	4
4200200266	PLASTICOS MODERNOS S A	924035	266	127,735	339,008.75	2.6529	431	3
4200260240	INDUSTRIAS DOYCO S A	924110	104	23,337	86,714.00	3.7157	225	3
4200205410	POLY PLASTICOS S A	910552	351	162,900	439,097.25	2.6955	465	3
4200201000	ALMACEN CENTRAL DEPOSITO	901662	7	164,342	333,431.00	2.0288	4343	2
4205600320	IMPRENTA NACIONAL GOBERN	924015	212	45,760	206,350.25	4.5094	216	2
4205605500	HULES TECNICOS S A	924136	245	59,500	252,374.50	4.2415	243	2
4205601020	FED COOP CAFICULTORES R-	910295	114	20,726	87,432.00	4.2184	132	3
4205601950	RECAUCHADORA GIGANTE SA	000000	125	23,756	97,901.00	4.1211	191	2
4205601980	TALLER COCCIO S A	909217	56	26,349	79,795.75	2.9723	49[illegible]	2
4205602000	POLIURETANOS S A	908930	79	21,542	71,270.25	3.3074	273	3
4205602480	POLIPAK DE COSTA RICA	000000	687	328,412	855,579.50	2.6045	479	2
4205602500	POLYMER LTDA	907267	515	233,100	636,225.25	2.7294	455	2
4205605800	MERCADOS GENERALES C A	910561	62	28,480	85,075.75	2.9872	480	2
4205606500	HOTELERA SANTA MARTA-S.A	906945	157	67,075	184,944.25	2.7572	428	3
4205606700	HOTELERA SANTA MARTA S A	905951	36	21,705	75,037.50	3.4571	252	3
4205605740	~~HOTEL IRAZU SA~~	~~000000~~	~~4CR~~	~~1631,836CR~~	~~2692,915.00CR~~	~~1.6502~~		~~3~~
4205606740	~~HOTEL IRAZU SA~~	~~000000~~	~~4~~					
4205606740	HOTEL IRAZU S A	906052	4	1631,836	2692,915.00	1.6502	1[illegible]6	3
4205640200	LACSA	910893	222	46,560	320,758.25	6.8891	210	2
4210200325	INST COSTARRICENSE A Y A	910563	984	576,600	1635,096.25	2.9224	[illegible]	2
4211560840	SAMUEL GRYNSPAN BURSTIN	910963	93	30,436	92,856.25	3.0508	[illegible]	3
4211801000	CANADA DRY BOTTLING-CO	909184	111	29,539	100,335.25	3.3987	[illegible]7	3
4212260240	HULES TECNICOS S.A.	906456	380	162,560	530,608.25	3.2640	[illegible]	3
4212100660	INMOVILIARIA VISION S A	910966	126	27,499	120,097.75	4.3673	219	2
4212100220	CORPORACION INYCO S A	906740	84	47,083	115,657.25	2.4564	[illegible]1	3
4212240160	TRANSPORTE INTER GASH S	908804	103	31,545	[illegible]	4.5467	[illegible]	3
4212[illegible]	FABRICA DE GALLETAS CRON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4212[illegible]	POZOLO SOCIEDAD ANONIMA	909841	311	106,350	[illegible]	[illegible]	[illegible]	[illegible]
4212460170	COMECA SA	000000	173	97,826	327,534.50	3.0616	344	3
4212460300	CANCO S A	901134	100	21,216	81,235.50	3.8289	346	2
4212601153	RUSELLO SA	909065	125	40,320	144,118.75	3.5743	223	2
4212601030	MATERIALES PRENSADOS S A	907009	201	33,292	175,864.00	5.2824	166	2
4212661120	IND CERAMICA COSTARR LTD	910542	165	54,590	168,468.75	3.0860	331	3
4212651132	INCESA STARDARD	000000	19	292,895	452,381.75	1.5445	2296	2
4212661140	INDUSTRIA CERAMICA COSTA	910324	161	66,218	185,538.75	2.8019	412	2
4212662000	FABRICA CALZADO SAN BOSC	912013	280	87,850	280,515.25	3.1931	314	2
4212800340	OSCAR CAMPOS BONILLA	907492	37	20,073	52,933.00	2.6370	543	3
4215400502	ORANGE CRUSH DE COSTA RI	908471	314	93,760	307,207.75	3.2765	299	3
4215701200	CAJA COST DE SEGURO SOCI	908920	756	364,800	1142,723.25	3.1324	482	2

TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	JUN T-5
4215701300	CAJA COST SEGURO SOCIAL	910390	101	24,806	99,493.75	4.0108	246	2
4215701940	INST NAC DE SEGUROS	910063	70	26,030	83,943.25	3.2248	372	2
4215704000	PATRONATO NAL REHABILITA	906840	128	50,913	166,252.75	3.2651	398	2
4215800060	CORP COST DE TELEVISION	908483	107	26,928	107,691.75	3.9992	252	2
4216920480	I N A	910577	88	24,235	91,211.25	3.7636	276	2
4216941200	ASOC PRO HOSPITAL NAL NI	910066	163	31,579	224,933.25	7.1228	194	2
4404521240	I.C.E.	906477	98	44,390	135,361.50	3.0626	452	2
4800400510	FABRICA DE TUBO TICO	000000	384	144,600	397,692.50	2.7502	377	2
4800400540	GALVATICA	908214	175	87,143	226,864.00	2.6032	499	3
4800400950	PLAST-IND SIETE-VIDAS S.	906955	516	169,200	531,929.25	3.1437	328	3
4800401100	MERCK SHARP Y DOHME CORP	905371	147	41,860	138,591.75	3.3108	285	3
4800420620	ALIMENTOS JACKS CENTROAM	906594	121	26,601	100,567.00	3.7805	220	3
4800420820	ACCES PLAST CENTROAMARIC	910916	274	138,560	360,679.75	2.6030	506	3
4800420840	PLASTICOS PARA CONSTRUCC	906429	456	166,800	497,993.25	2.9855	366	3
4800421180	INDUSTRIA TEXTIL S A	910325	232	35,496	170,654.75	4.8077	153	3
4800530240	SYLVANIA CENTROAMERIC S.	905635	528	184,800	563,513.25	3.0493	350	3
4800540140	ALIMENTOS JACKS DE-C.A	910911	214	52,224	189,088.50	3.6207	245	3
4800541000	TICAKNIT S A	905634	288	60,000	233,841.25	3.9806	200	3
4800541110	HO DO LEE S A	910607	147	38,325	230,075.75	6.0032	261	2
4800550100	COMBA S A	900975	78	21,216	70,235.50	3.3104	272	2
4800551000	INDUPLASTIC S A	906906	159	29,539	143,657.75	4.8633	186	2
4801310120	INDUSTRIAS POLIANDY S A	905969	106	23,500	97,981.25	3.7438	235	2
4801311460	CARIBBEAN VENEER CO.S.A	906602	106	44,716	122,775.50	2.7456	422	2
4801311600	CUADRADA CENTROAMERICANA	906479	144	40,800	135,353.25	3.3174	284	2
4801392040	COOP PROD DE LECHE R L	924023	151	26,438	115,299.50	4.3611	176	3
4801451200	C MORENO Y CIA S A	910835	98	20,848	79,632.00	3.8196	213	3
4804000720	ROSAGO S A	924072	119	25,704	98,095.75	3.8163	215	3
4804305400	ICE	910567	152	50,872	130,450.50	3.5471	335	2
4804901300	INST COST DE ELECTRICIDA	907263	144	62,995	193,964.50	3.1524	437	2
4807021200	CAJA COSTARRICEN SEG SOC	908224	252	97,920	330,307.50	3.3732	389	2
4807100760	DEMASA	910569	552	247,200	677,849.25	2.7421	448	2
4807220460	PRODUCTOS COLUMBIA S A	905364	92	21,134	87,638.50	4.1463	230	2
4807220500	STAJAPARI	910580	500	75,600	270,425.25	3.5770	222	3
5001431180	PROD ALIMENTICIOS NAL-S.	910564	474	208,500	575,381.25	2.7596	442	3
5001431500	TENERIA PRIMENCA LTDA	906412	115	25,459	95,694.01	3.7587	223	3
5001431540	FAB DE CALZADO EL PROGRE	906462	105	20,563	82,664.48	4.0200	194	3
5002601100	GOLDEN PLASTIC S A	906465	92	22,343	79,911.99	3.4275	242	3
5002724440	FABRICA PRODUCTOS TEGA	909659	133	34,516	119,547.51	3.4635	266	3
5002844000	COOP SERV AEREO INDUSTRI	908921	92	21,053	76,966.61	3.6560	229	3
5003001040	MINIST OBRAS PUBL Y TRAN	907258	262	140,000	629,855.50	4.4989	515	2
5003001380	DIRECC GRAL AVIACION CIV	910033	90	29,539	156,403.83	5.2942	329	2
5003001400	MINIST OBRAS PUBL Y TRAN	908223	154	61,363	306,950.40	5.0033	399	2
5003001700	COOPERATIVA SERVICIO AER	906434	241	56,795	244,798.50	4.3105	236	2
5003003150	CINTA AZUL S A	938034	113	49,449	205,284.22	4.1514	438	4
5003003200	HENDERSON COMPAÑIA LTDA	910598	430	89,100	332,565.25	4.2936	176	3
5401901750	ELASTICA SURQUI S A	906488	89	23,664	79,750.21	3.3701	265	3
5604931561	ESCAMA S.A.	909864			750.25	750.2500		3
5605520840	YOSHIDA DE COSTA RICA	906583	130	33,619	116,576.50	3.4675	259	2
5605521540	FLEXOPRINT S A	924066	279	112,480	374,334.50	3.3270	414	2
5605530520	FAB ROPA JUPITER	938002	194	44,471	193,034.25	4.3457	100	2
5602400620	EMPAQUES ILUSION LTDA	905332	92	27,417	87,405.25	3.1879	299	2
5605431700	INS INT CIENCIAS AGRIC	910081	171	45,451	181,351.33	3.9900	206	2
5607502100	COOP AGROPECUARIA CORONA	910531	364	111,240	365,874.75	3.2441	306	3
5607900101	COOP CORONADO	910241			20,635.35	635.3500		3

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TARIFA-4 MAS DE 20000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	JUN T-S
6203200280	CONVERTIDORA NAL DE PAPE	909157	121	21,540	92,270.07	4.2832	179	3
6203201000	MONTE ROMO S A	938036	265	37,209	189,964.01	5.1053	141	3
6203261050	ARROCERA LA GILDA	910595	420	66,675	315,788.25	4.7362	159	3
6203520400	CERVECERIA TROPICAL S.A	906331	434	198,100	538,325.25	2.7174	457	3
6205501440	ARROCERA CHINA S A	906912	118	31,660	107,363.64	3.3911	269	3
6400060460	COMP MANUFACTERA COST SA	909656	255	78,336	294,492.00	3.7595	[illegible]	2
6400460100	FAB ROPA EL ACORAZADO S	910529	126	30,232	109,021.83	3.6051	240	3
6400460120	FABRICA ROPA ACORAZADO	924049	175	32,884	242,217.84	7.3658	123	2
6405041020	TIBACENTRO S A	909645	64	29,865	88,449.33	2.9616	467	3
6405044000	LA NACION S A	000000	282	148,500	383,828.75	2.5347	527	3
6406420200	I C E	907257	144	61,036	195,203.25	3.1931	424	2
6410502100	ASFALTOS NACIONALES SA	000000		38,129	72,638.00	1.9050	2129	2
64[illegible]320500	LITOGRAF E IMP LEHMANN	907032	203	59,731	227,817.50	3.8140	295	2
6415941580	PRODUCTOS PLASTICOS SIRE	910690	126	22,480	96,308.42	4.2841	172	3
6605000700	INDUSTRIAS BUENOS AIRES	924054	167	51,244	163,981.50	3.2000	307	4
7290630000	CO BE S A	900554	182	27,172	152,803.84	5.6235	150	2
7291200000	PIELES COSTARRICENSES S	907274	700	239,750	739,631.25	3.0850	343	3
7291460000	PRODUCT. DE CONCRETO S.A.	909797	157	30,028	124,187.31	4.1357	103	4
7291500000	PIPASA	906256	255	137,822	349,269.35	2.5392	541	2
7291501000	PIPASA	910078	123	62,791	160,918.50	2.5627	511	3
7291995000	MINISTERIO DE JUSTICIA	910315	67	31,946	93,516.23	2.9277	477	2
7291995500	MINISTERIO DE JUSTICIA	910574	62	22,195	73,008.65	3.2894	[illegible]	2
7292250000	MINISTERIO DE JUSTICIA	910613	263	168,000	471,409.00	2.8060	639	2
7294010000	EMPAQUES UNIVERSAL S A	909222	372	189,760	493,647.75	2.6014	511	3
7400120030	INST COST-DE ELECTRICIDA	910579	735	328,125	1059,807.50	3.2298	447	2
7401000650	SANTIAGOMILLAS S.A.	901281	77	29,760	95,271.54	3.2013	337	2
7401521200	PRODUCTOS GERBER DE C A	000000	444	187,160	514,679.25	2.7499	422	2
7401521440	PRO-GERBER CENTROAM S.A	907575	432	118,800	407,273.25	3.4282	275	2
7403000130	BCO NAL DE COSTA RICA	907551	94	24,235	94,782.31	3.9100	258	2
7403010380	ARTIAGO HERMANOS Y-CIA	906753	159	29,376	124,117.95	4.2251	185	3
7403060090	IZQUIERDO Y QUESADA	906426	53	26,846	72,724.33	2.9324	507	3
7404000340	SERI PLASTIC DE CENTROAM	924117	184		173,003.60	3003.6000		2
7404300180	DADA HNOS LTDA	906768	126	26,601	103,066.98	3.8745	212	3
7404510740	STERLING PROD INTERNAT	905511	170	58,752	177,794.50	3.0261	346	3
7404524520	UNIVERSIDAD DE COSTA RIC	906952	72	23,500	80,276.25	3.4160	327	2
7404552530	UNIVERSIDAD DE COSTA RIC	906636	131	38,515	144,224.08	3.7446	295	2
7404551460	ESC DE INFORMATICA D U C	905515		23,990	63,655.21	2.6659	1990	2
74[illegible]329810	EXPORTADOR TRIPLE SIETE	906646	384	85,200	384,458.25	4.5124	222	3
74[illegible]051000	CIA TEXTIL CENTROAMERICA	906548	612	214,800	654,713.25	3.0480	351	3
7600120555	VARGAS PEREZ RAFAEL E	000000	9	35,175	66,806.50	1.8992	1909	3
7602860760	INDUSTRIAS SEDALANA	910882	318	66,000	263,681.25	3.9951	208	3
7602861761	INDUSTRIAS SEDALANA	910303		28,314.85	8314.2500			2
7602160220	INDUSTRIA DISCOS CENTROA	909156	131	22,343	99,411.99	4.3510	175	3
7606162000	PALACIO DEL ROLLE S A	907013	103	27,417	92,905.19	3.3885	267	3
7606162520	EATON CONTROLES INDUSTR	902484	228	51,244	194,481.50	3.7952	225	2
7606940640	C F G LIMITADA	924012	106	25,296	90,926.63	3.5945	239	6
7891735000	QUEBRADORES EL RUANO S A	912014	276	40,200	200,369.30	4.9843	144	4
8012802380	INDUST KAN LUNG S A	910585	683	72,450	456,759.25	6.3044	107	3
8401805360	S H A A	906612	222	151,449	415,225.75	2.7416	423	2
8403801[illegible]	SNAA	000000	160	112,380	136,632.75	1.2104	2[illegible]	2
8405004000	FIDEOS P[illegible]COCIDOS DE C P	910977	79	23,664	74,750.21	3.1585	[illegible]	3
8603187000	SINTETICOS S A	000000	160	64,760	178,544.50	2.7570	4[illegible]	3
8603187100	KATIVO S A	902460	600	186,000	601,481.25	3.2337	1[illegible]	2
8616101400	TEXTILERA TRES RIOS S.A.	903916	768	372,000	980,521.25	2.6626	4[illegible]	3

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TARIFA-4 MAS DE 2000 KWH

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS USO	30 JU T-2
8617400000	HACIENDA LA UNION	910233	70	20,604	65,231.72	3.1659	295	3
8620001000	TEXTILERA RIO AZUL	909178	114	42,350	122,395.15	2.9013	372	3
8620500700	PRODUCTOS CONCRETO S.A.	906431	548	119,520	466,454.00	3.9027	219	3
8625000140	COMTEC SA	000000	300	52,200	279,647.25	5.3575	174	2
8625000320	YUCA TICA S A	906752	113	56,703	146,081.75	2.5721	503	3
9000103960	RADIO COLUMBIA LTDA	909647	50	25,867	75,773.25	2.9295	519	2
9004800600	FABRICA DE PRODUCTOS STA	910085	312	96,000	309,381.25	3.2279	308	3
9010060300	PRESIDENCIA DE LA REPUBL	905697	143	47,040	167,735.75	3.5658	329	2
ABONADOS	378		81028	30080,635	94421,902.71	3.1389	372	

1530

175 usuarios $ 72,140

-9/3 1/9 [illegible] Pargo (d I dán demand

(1 2 10,000 kwt/mes)

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TARIFA-7 BOMBAS DE AGUA

LOCALIZAC.	NOMBRE	NO. MEDIDOR	DEMANDA	K.W.H.	IMPORTE	PRECIO/KWH	HORAS	USO	SC JU T-S
2800100450	INST COST ACUED Y ALCANT	909794	193	131,539	159,195.75	1.2026	[illegible]		2
2800805460	E.S.P.H.	907899	1	163	5,097.63	31.2738	163		2
2806000040	ICAYA	906860	208	136,320	165,903.50	1.2170	656		2
3001301500	MUNICIPALIDAD DE BELEN	800096	8		5,097.60	5097.6000			2
3001305000	MUNICIPALIDAD DE BELEN	908084	23	10,322	15,717.44	1.5227	449		2
3003000900	SERV NAL DE A Y A	910076	59	40,840	50,789.11	1.2436	693		2
3004100300	MUNICIPALIDAD SANTA ANA	909060	27	12,444	19,830.58	1.5132	461		2
3400660820	SERV NAL ACUEDUCTOS ALCA	800019	80	21,307	38,663.50	1.8145	267		2
3400700600	S N A A	910314	40	11,954	20,232.37	1.6925	299		2
3403901420	ASOC DE DESARROLLO RIO A	910865	12	8,404	11,778.92	1.4015	701		2
4212880240	SERV NAL ACUAD Y ALCANTA	906608	102	69,196	84,096.75	1.2153	679		2
5800052940	S N A A	910997	104	53,600	71,813.25	1.3397	516		2
5[illegible]0033000	SNAA	906616	114	77,520	93,952.50	1.2119	680		2
7405641740	ACUEDUCTOS Y ALCANTARILL	907039	33	18,196	26,531.75	1.4581	552		2
8092035000	MUNICIPALIDAD SANTA ANA	910196	6	3,200	5,333.55	1.6667	534		2
8401405080	SERV NAL DE ACUED Y ALCA	909790	69	45,206	56,092.52	1.2408	656		2
8401620100	INST COSTARR A Y A	910457	79	42,560	56,447.74	1.3263	539		2
8401805200	SERVICIO NACIONAL DE ACU	906610	188	125,174	151,713.75	1.2120	666		2
8403650100	SERV NAL ACUEDUC Y-ALCAN	910905	102	74,174	88,178.75	1.1838	729		2
8403753000	INST COSTARRICENSE DE A	909795	170	109,017	133,920.00	1.2284	643		2
8403805040	SERV NAL ACUED Y ALCANT	909789	208	143,126	171,484.50	1.1981	659		2
ABONADOS	21			1134,262	1429,371.44	1.2606			

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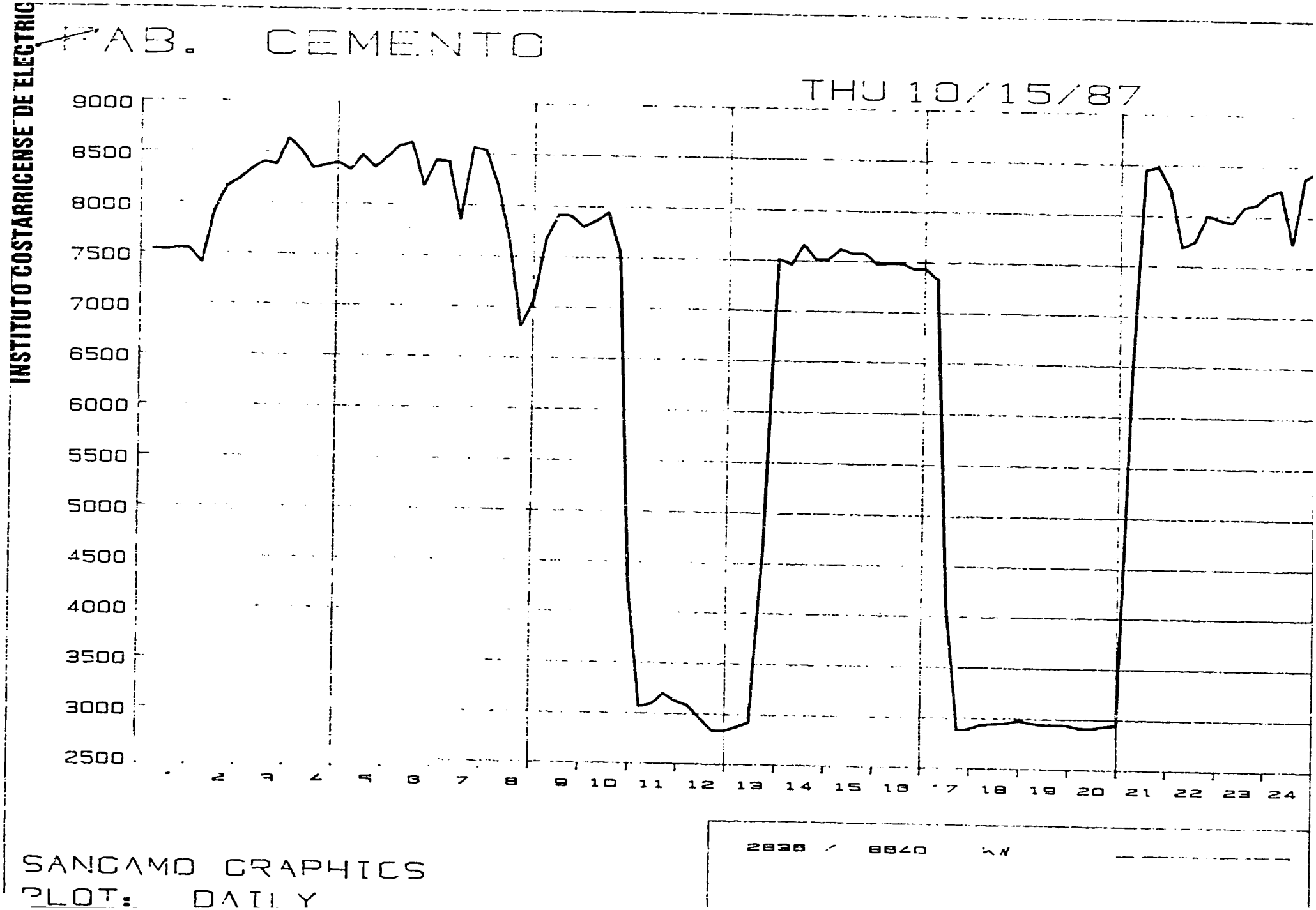
Annex A1.13


INSTITUTO COSTARRICENSE DE ELECTRICIDAD
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2838 / 8640 kW
SANGAMO GRAPHICS
PLOT: DAILY

APPENDIX B: REPRESENTATIVE SAMPLE OF ENERGY MANAGEMENT SYSTEM (EMS) MANUFACTURERS

Andover Controls Corp.
York & Haverhill Sts.
Andover, Mass. 01810

Barber-Coleman Co.
Environmental Controls
Division
1354 Clifford Ave.
Loves Park, Ill. 61132

Butler Controls Div.
Butler Manufacturing
12277 134th Court N.E.

Honeywell Inc.
Commercial Division
Honeywell Plaza West
Minneapolis, Minn. 55408

Johnson Controls Inc.
P.O. Box 423
Milwaukee, Wisc. 53201

Novar Controls Corp.
24 Brown St.
Barvertown, Ohio 44203

Robertshaw Controls Co.
Controls Systems Div
P.O. Box 27606
Richmond, Virginia 23261

Square D Company
P.O. Box 472
Milwaukee, Wisconsin 53201

MAJOR SUPPLIERS OF ENERGY MANAGEMENT SYSTEMS

Admic Controls, Unit 2, 33 Glen Cameron Rd., Thornhill, Ontario, Canada L3T 1N9

American Multiplex Systems Inc., 1148 E. Elm Ave., Fullerton, CA 92631

AMF Controls Systems, P.O. Box 59469, Dallas, TX 75229

AMF Paragon Electric Co., Inc., 606 Parkway Blvd., Doylestown, PA 18901

Anderson Cornelius Co., 6750 Shady Oak Rd., Eden Prairie, MN 55344

Andover Controls Corp., Bldg. 5, Floor 5, York and Haverhill St., P.O. Box 34, Shawsheen Village Station, Andover, MA 01810

Atlantic Energy Technologies, Inc., 10 Keith Way, Hingham, MA 02043

Automation Concepts, 2460 Walnut Ridge, Dallas, TX 75229

Automation Controls Corp., 672 N.E. 40th Ct., Ft. Lauderdale, FL 33334

Barber-Coleman Co., Energy Management Group, 1300 Rock St., Rockford, IL 61101

Beckman Instruments, Process Instruments and Controls Group, 2500 Harbor Blvd. Fullerton, CA 92634

Bendix, Environmental Process Instruments Div., P.O. Drawer 831, Lewisburg, WV 24901

BioniControls Corp, 2410 Gilbert Ave., Cincinnati, OH 45206

Butler Controls Div., Butler Manufacturing Co., 11825 120th N.E., P.O. Box 2249, Kirkland, WA 98033

Chesterfield Products Inc., 511 Victor St., Saddle Brook, NJ 97662

Climatron Inc., 1370 Logan Ave., Costa Mesa, CA 92626

Computer Controls Corp., 54 Industrial Way, Wilmington, MA 01887

CSL Industries, One Centry Plaza, 2029 Century Park East, Los Angeles, CA 90067

Cutler-Hammer, 4201 N. 27th St., Milwaukee, WI 53216

Cutler-Hammer Electrical Electronic Control, Div. of Eaton Corp., 2620 Lance Dr., Kettering, OH 45409

Digital Equipment Corp., 146 Maynard St., Maynard, MA 01754

Distributed Control Systems Inc., 1 DSC Plaza, Great Neck, NY 11021

Diversified Energy Systems Inc., King of Prussia Business Center, 1017 W. 9th Ave., Suite D, King of Prussia, PA 19406

Eagle Signal Energy Management Systems Inc., Div. of Gulf & Western, 30 Main St., Danbury, CT 06910

Eaton Controls Corp., 100 Erieview Plaza, Cleveland, OH 44114

Econowatt Corp., P.O. Box 321, Pelham, NY 10803

Enco 2000 Inc., 3162 Oakcliff Industrial St., Atlanta, GA 30340

Enercon Data Corp, 7117 Ohms Lane, Edina, MN 55435

En-Log Corp., 17152 S.W. Upper Boones Ferry Rd., Tigard, OR 97223

Foxboro Corp., 38 Neponset Ave., Foxboro, MA 02035

Functional Devices, 310 S. Union St., Russiaville, IN 46970

General Electric EMS, 225 Service Ave., Warwick, RI 02886

GTE Sylvania, 100 Endicott St., Danvers, MA 01923

Honeywell Inc., Commercial Div., Honeywell Plaza, Minneapolis, MN 55408

Honeywell Inc., Energy Products, 1985 Douglas Dr. N., Golden Valley, MN 55422

Honeywell, Inc., Process Management Systems, MS143, 2222 W. Peoria Ave., Phoenix, AZ 85029

IBM, General Systems Div., P.O. Box 2150, Atlanta, GA 30301

Johnson Controls Inc., P.O. Box 423, Milwaukee, WI 53201

Leviton Manufacturing Co., Inc., 59-25 Little Neck Pkwy., Little Neck, NY 11326

Litton Facility Management Systems, 1213 N. Main St., Blacksburg, VA 24060

Margaux Controls Inc., 2890 N. First St., San Jose, CA 95134

Margaux Controls, 2302 Walsh Ave., Santa Clara, CA 95050

MCC Powers, Inc., Unit of Mark Controls Corp., 2942 Macarthur Blvd., Northbrook, IL 60062

McQuay Group, McQuauy-Perfex Inc., 15600 Industrial Park Blvd., P.O. Box 1551, Minneapolis, MN 55440

MicroControl Systems, Inc., 6579 N. Sidney Pl., Milwaukee, WI 53209

National Enco 370 West Salisbury St., Asheboro, NC 27203

Novitas Inc., 1523 26th St., Santa Monica, CA 90404

Pacific Technology, Inc., 235 Airport Way, Renton, WA 98055

Pacific Technology Div., Butler Manufacturing Co., P.O. Box 2249, Kirkland, WA 98033

PowerLine Communications, Inc., 123 Industrial Ave., Williston, VT 05495

Radix II Inc., 4588 Beech Road, Marlow Heights, MD 20031

Robertshaw Controls Co., Controls Systems Div., 1800 Glenside Dr., Richmond, VA 23226

Robertshaw Controls Co., 3000-B South Highland Dr., Las Vegas, NV 89109

Scientific Atlanta, Inc., 4300 Northeast Expressway, Atlanta, GA 30340

Solid State Systems, Watt Shaver, 1990 Delk Industrial Blvd, Marietta, GA 30067

Solidyne Corp., 205 W. 35th Street., Unit A, National City, CA 92050

Sparton Technology, P.O. Box 472, Milwaukee, WI 53201

Square D. Co., N. Richards St., P.O. Box 472, Milwaukee, WI 53201

Staefa Control System Inc., 2481 San Leandro Blvd., San Leandro, CA 94577

Sunmaster Corp., 35 West William St., P.O. Box 1077, Corning, NY 14830

Systems Technology Corp., 18845 W. McNichols, Detroit, MI 48219

Teletrol Div., Anchor-Hocking, 11214 Shappert Dr., Rochford, IL 61111

Toledo Scale Energy Micro-Systems, 350 W. Wilson Bridge Rd., Worthington, OH 43085

Tork Inc., One Grove St., Mt. Vernon, NY 10550

Trimax Controls, Inc., 1180 Miraloma Way, Sunnyvale, CA 94086

Tour and Anderson Inc., 652 Glenbrook Rd., P.O. Box 2337, Stamford, CT 06906

Vigilance Systems Corp. 66 Dyke Lane, Stamford, Ct 06902

Weltronics Co., 495 Holley St., Clare, MI 48617

Westinghouse Electric Corp., Computer Instumentation Div., 1200 W. Colonial Dr., Orlando, FL 32804

Xencon, 150 Mitchell Blvd, San Rafael, Ca 94903

APPENDIX C: SUMMARY OF SITE VISITS

Instituto Costarricense de Electricidad (ICE)

Compania Nacional de Fuerza Y Luz (CNFL)

San Jose, Costa Rica - Central America

November 2 through November 11, 1987

List of Visits:

1. Ticatex (textile mill) - Nov. 2
2. Conducen (electrical conductor manufacturer) - Nov. 3
3. Hotel Cariari - Nov. 3
4. Fabrica de Cemento (cement plant) - Nov. 3
5. Compania Numar (margarine, cooking oils, lard) - Nov. 3
6. Hospital Mexico - Nov. 4
7. Fabrica Nacional de Liquores (liquor distillery) - Nov. 4
8. Cerveceria Costa Rica (brewery) - Nov. 4
9. Cafetalera Pilas / Orcafe (coffee processing) - Nov. 4
10. Fertica (fertilizer plant) - Nov. 5
11. Fabrica de Hielo Gutierrez (ice plant) - Nov. 5
12. El Angel (fruit canning) - Nov. 5
13. Hotel Tamarindo - Nov. 6
14. Carnes de Centroamerica (meat packing) - Nov. 6
15. Molinos de Costa Rica (wheat processing) - Nov. 9
16. Productos Gerber de Centroamerica (fruit conc.) - Nov. 9

17. El Gallito Industrial - (confectionery, choc.) - Nov. 10
18. Ricalit (fiber cement products) - Nov. 10
19. Miller Hermanos (air separation) - Nov. 10
20. Hotel Aurola / Holiday Inn - Nov. 11
21. Laminadora Costarricense (steel mill) - Nov. 11
22. Cooperativa Victoria (sugar mill/coffee proc.) - Nov. 11

CONFERENCE HIGHLIGHTS AND LOAD MANAGEMENT OPPORTUNITIES

1. **TICATEX (textile mill) / Nov. 2** - Sres. Luis Lanzoni (39 00 11) and Luis Alfonso Fernandez, Engineering Dept. Continuous operation, 650 employees, fabrics manufacturing process starts with cotton bales. No structured load control program. Opportunity to interrupt operation of 150 KW ELECTRIC INFRARED HEATERS - only equipment that does not operate continuously. Additional opportunity to reduce output from 500-WATT FLUORESCENT LAMPS DOWN TO 30% LEVEL = 14 KW REDUCTION in weaving (tejidos) dept. with dimming system that could be installed at the lighting panel and operated from EMS during on-peak hours. **ESTIMATED CONTROLLABLE LOAD = 164 KW.** Additional study should be made to determine: if 300-ton Mitsubishi chiller could be partially downloaded; and if exhaust fan capacities allow load reduction during peak hours. **GOOD CANDIDATE FOR PILOT PROGRAM.**

2. **CONDUCEN (elect. conduct. manuf.) / Nov. 3** - Ing. Eduardo Gomez Laurent, Jefe Departamento Ingenieria y Mantenimiento (39 12 22). Continuous operation, 250 employees, cable & conductor manuf. process starts mostly with rolls of wire (alambron) shipped in spools from Peru. Annual production: 2 to 3k tons in copper and 1k tons in alum. No load control program, but Ing. Gomez showed great interest in options that could help reduce kW demand. Very interested in receiving a pulse from ICE. Feels that MANAGEMENT WOULD INVEST IN AN EMS. Have a 200 kw generator, and would be interested in "peak shaving". Plant will experience a $1 million (US) expansion in electrical production equipment

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in 1988, which could allow for additional load control opportunities in the future. Good opportunities to run a 90 kW oven (2 to 4 month/year operation) and a 90 kVa bow twister (cableadorea with flexible operation) outside of peak hours. Assuming a 50% power factor on the bow twister and a 75% diversity in oven operation kw, **ESTIMATED CONTROLLABLE LOAD = 146 KW. GOOD CANDIDATE FOR PILOT PROGRAM.**

3. **HOTEL CARIARI / Nov. 3** - Ing. Carlos Roesch C., General Manager (39 00 22), is also a mechanical/electrical engr. with great interest in energy management and load reduction. Hotel has a strong group of owners whose reinvestment in the property has seen the hotel grow from 56 to 188 rooms. A new expansion will begin in January and include: 6,000 sq. mtrs: 30 rooms, a greatly enlarged lobby; a 1500-person convention center; and three conference rooms for 120 persons each. Mr. Roesch projects a 35% increase in electrical consumption. An energy study was prepared several years ago by a retired engineer. The recommendations were implemented and resulted in a 23% reduction in consumption. Mr. Roesch is extremely interested in participating in pilot program and is willing to fund load control equipment investment. Four main central A/C units serve the facility: (1) 60-ton, (2) 45-ton, and (1) 30-ton (suites) units. Mr. Roesch indicated that the split system serving the restaurant is oversized. This might present an opportunity for duty cycling this unit with (2) walk-in freezers at 7-1/2 HP ea., (2) large coolers at 5 HP ea., and (1) upstairs cooler at 5 HP. In addition, there may be an opportunity to use time-of-day scheduling for controlling the operation of (3) 600 lb. ice makers, (2) 400 lb. ice makers, and (4) ice cube machines in the hallways. Additional study is necessary to

quantify the duty cycling capability of the systems, including override temperatures at which the freezers would not be shut off to prevent spoilage of the stock. Future expansion calls for two 60-ton A/C units. The hotel is presently served from three service points. It would probably be advisable, from the customer's point of view, to consolidate the services through a single meter to take advantage of natural equipment diversity to reduce the total, effective kw demand level. From the utility's point of view, it would make it simpler to implement load control event through a centralized point. It is estimated that the **CONTROLLABLE LOAD 20 KW.** However, this facility is also recommended for the pilot program due to the following reasons: (1) excellent relationship with ICE; (2) Strong technical background and facility familiarity of the management; (3) future marketing/testimonial ads, etc. opportunity for promoting load control to similar facilities; and (4) management's great interest in the project. **GOOD CANDIDATE FOR PILOT PROGRAM.**

4. **FABRICA DE CEMENTO (cement plan) / Nov. 3 -**

5. **COMPANIA NUMAR (margarine, cooking oils, lard) / Nov. 3 -**

6. **HOSPITAL MEXICO / Nov. 4 -** Ing. Gerardo Diaz (32 53 13). Only a brief meeting was possible with Mr. Diaz. He asked that the facility/equipment inventory forms be left behind so that his staff would complete them. A tour of the facilities was not possible at the time. The 627-bed hospital has a sewing shop and a separate laundry building. It has three emergency generators: (2) 200 kW and (1) 300 kW. The boilers run on bunker oil. The main cooling system is an 80-ton system that operates continuously. Other

package units serve facilities including delivery rooms (20 tons), operating rooms (40 tons), and emergency room (15 tons). The forms were returned partially completed and a more thorough on-site investigation is advised. In addition, a meeting with Mr. Diaz' superior is recommended to propose whatever load control options might be appropriate. Based on the limited information and accessibility at the time of the visit, the hospital is currently considered a **POOR CANDIDATE FOR THE PILOT PROGRAM. It is recommended that solid state data receiver - type metering be installed to obtain valuable load curve data for future activities.**

7. **FABRICA NACIONAL DE LIQUORES (liquor distillery) / Nov. 4** - Ing. Eugenio Alpizar (44 54 58). Plant operates continuously for 150 to 200 days/year on a seasonal basis. From Feb., March, May, June, part of August, & various other dates. Principal products are rum and industrial alcohols. Work stoppages are caused by quota system. Raw material is molasses, and arrives by tank trucks at various hours. Demand load curves (9/8/87 & 9/16/87) show a continuity of narrow, intermittent peaks in the 75 kW range through a 24-hour period. Mr. Alpizar expressed a concern for the high water consumption in the plant and identified it as a targeted area for conservation. It might be possible that one or two of the water storage pumps (50 hp & 35 hp) could operate outside of utility on-peak hours if the fire water storage tank can be connected with the plant water supply tank. In addition, scheduling of the molasses tank truck arrivals could permit unloading during off-peak hours and keep three 12.5 hp transfer pumps form contributing to the peak demand. **ESTIMATED CONTROLLABLE**

<u>LOAD: 60 KW.</u> It is recommended that solid state electronic meter be installed. MEDIUM CANDIDATE FOR PILOT PROGRAM.

8. **CERVECERIA COSTA RICA (brewery) / Nov. 4 - (41 02 22)**

9. **CAFETALERA PILAS (ORCAFE) / Nov. 4 - Mr. Roberto Kopper O., Administrator (22 67 22).** This 15,000 hectare plantation processes its own coffee crop in addition to that purchased from approx. 1500 other small growers in the area. Production is measured in fanegas (approx. 100 lb.). Average production per growing season is 60 to 70,000 fanegas. Most of the processed beans are for international export, mainly Europe. Most of the coffee wholesaler in San Jose are German. A demand monitoring system was installed at the processing plant and is used in conjunction with an alarm system which is used ten out of the twelve months to warn the workers to turn off equipment during utility on-peak periods. Mr. Kopper indicated that during the two peak production months its not possible to implement any load shedding. However, during the rest of the year the control system is used to cut demand to approximately half during the on-peak hours. The cost of the system was 65,000 ($980 US). Annual savings since implementing the manual load shedding procedure was estimated by Mr. Kopper at 700,000 ($10,570 US) in 1985, and 839,000 ($12,660 US) in 1986. Although this facility may not be a good candidate for direct load control by the utility, **it is recommended that installation of electronic pulse metering be considered for research purposes.**

10. **FERTICA (fertilizer plant) / Nov. 5 -**

11. **FABRICA DE HIELO GUTIERREZ (ice plant) / Nov. 5 -**

12. **EL ANGEL (fruit canning & packaging) Nov. 5 - Sr. Jose Kutscherauer, vice president (47 20 78 & 35 50 91).** The plant is located on a 500 hectare farm. Although the farm has 10,000 guava trees and some coffee, most of the fruit that is processed in jams, jellies, fruit and juice concentrates, and candied fruit is purchased from nearby growers. Other products include ketchup, maple syrup, and apple and pineapple fruit filler packages for Mc Donalds. The plant also purchases milk brought in by the locals seven days a week to produce condensed milk. Twenty five to thirty percent of production is exported to Miami, Puerto Rico and Central America. Mr. K. expects production to increase from increased export activities in the future. Opened in 1983, the plant has experienced substantial growth in production and electrical consumption. Although the plant peaks at 1,000 to 1,300 kW, billed demand has been kept at less than 30 kW during the utility's on-peak hours during the past two years. This has been the result of a time-clock controlled alarm system that warns the workers 15 minutes prior to the on-peak period to manually shut the plant down. Although the manual procedure has been effective in the past, Mr. K. is replacing it with an EMS that will turn the equipment off automatically. Most of the terminal load needed by the various processes is supplied by two 150 HP electric boilers. Back-up boiler capacity is available that runs on bunker fuel. This facility has been an excellent example of voluntary load control, and Mr. K. is very interested in participating in the load control program. For this reason, along with the installation of the new EMS, and expected growth in electrical demand, this facility is considered a **GOOD CANDIDATE FOR**

PILOT PROGRAM.

In addition, Mr. K. has a great interest in power generation. The farm has a 5 kW hydroelectric system which was used for power during the plant's construction and is still in use. Mr. K. has already obtained a permit to generate 450 kW from a separate hydro-generation project which he is developing within the plant's mountainous property. The property lies contiguous to two rivers (El Angel & ?) between which Mr. K. plans to install the penstock. The turbine is in storage in a warehouse and the spillway structure is nearly completed. Mr. K. indicated from his studies that he could possibly generate as much as 2 MW of which he would be able to sell approx. 750 kW to ICE during the dry season. He is very interested in funding assistance/participation from AID or any other viable organization and would like to discuss his project with ICE in the future.

13. **HOTEL TAMARINDO / Nov. 6 - Mr.** This 54-room beach hotel (4-suites) built in 1974, is located in the Pacific coast town of Tamarindo and is served by the Cooperativa Guanacaste. Air conditioning, lighting and water heating account for most of the electric load. Except for some electric fryers, most of the cooking is done with bottled gas. The rooms are air conditioned with 1-ton wall units of which there are a total to 58 (suites have two units each). The wall units are served from a panel at each floor of the three-story building. Water heating is done with (10) 50-gallon units have two 1,500 watt elements each. The laundry facility is not within the hotel and is served by a separate service. There is an opportunity to duty cycle the wall units (21 kW reduction) using one of two EMS power line carrier

options which need additional investigation: (1) duty cycling a/c operation by floor by installing a receiver at the a/c panels in each floor; or (2) duty cycling the units individually by installing a receiver at the receptacle connection in each floor. It would be necessary to check if the starting current from all the units in one floor starting at once would trip the breaker. If that were the case, then the alternative might be to cycle the units individually. An additional opportunity might exist to duty cycle the 5 HP and 1 HP compressors for the walk-in freezers. A study would be necessary to quantify the duty cycling capabilities of these units and determine override temperatures at which the freezers would not be turned off in order to prevent spoilage of the stock. Investigation should also be considered to either disconnect some of the heating elements or duty-cycle the electric during afternoon peak hours. The hotel might achieve an additional 2 kW of demand and energy savings by converting hallway lighting to the "PL" type fluorescent screw-in lamps. **APPROX. CONTROLLABLE LOAD: 25 KW. GOOD CANDIDATE FOR PILOT PROGRAM.**

14. **CARNES DE CENTROAMERICA (meat packing) / Nov. 6 -**

15. **MOLINOS DE COSTA RICA (wheat processing) / Nov. 9 - Mr. Rafael Carrillo, general manager ( ) & Mr. Enzo Proara, plant manager.** Built in 1967, the plant receives 100% of the wheat it processes from the US. It processes 10,000 tons/month in its milling operation and processes 1,350,000 50kg bags of flour each year. It's one of the largest such operations in Central America. All of its product is for internal consumption in Costa

Rica. Of the final product, 75% is for wheat products and 25% is produced for animal feeds. The facility is composed of three main areas: the storage silos (26,000 tons), the processing plant (26,000 tons/2.5 months), and 4,5000 sq. mtr. storage warehouse. Wheat is received by railroad and is unloaded at the rate of two tank cars per 15 min. It is a year-round, continuous operation where even a temporary power outage is extremely disruptive to the process. After a power interruption, it takes at least 1/2 hour to restore operation from lines that get clogged. The largest motor load are used for the grain transport equipment and for the air turbine blowers, with typical sizes in the 150 and 200 HP range. Again, plant management emphasized that it would be highly likely that load control-type interruptions would severely curtail production due to the continuity of the process. The plant is the main source of flour for Costa Rica. Electricity represents approximately 4% of the plant's annual operating cost. **POOR CANDIDATE FOR PILOT PROGRAM.**

16. **PRODUCTOS GERBER DE CENTROAMERICA (banana *concen-trate & dry cereals) / Nov. 9 Mr. Roy D Aragon, Special Projects Manager (25 84 11).** The 20-year-old plant occupies 1,860 sq. mtrs. and its rapid expansion will cause its relocation to a more industrial area within the next five years. Seventy (70) percent of its operation is for the production of banana puree concentrate which is packaged in 70Lb cylinder cartons and shipped to the US in refrigerated containers. The plant is one of the largest in Central America and processes 250,000 lbs of fresh bananas/day. Expansion is under way to increase its capacity to 400,000 Lbs/day. Although they have been exercising manual load control to keep approx. 350 kW outside of the

utility peak periods, they have missed it a couple of times. Management has approved an expense of 180,000 ($2,716 US) to install an EMS. Mr. Aragon expressed great interest in participating in the load control pilot program, as it would serve as a form of insurance for their load control efforts. Insuring load shedding of current non-essential loads (350kW) in addition to future expansion (23.0 - 65%) will result in a total load from cont. load of 580. kW. **CONTROLLABLE LOAD WOULD EQUAL APPROX 500 KW. GOOD CANDIDATE FOR PILOT PROGRAM.**

17. **EL GALLITO INDUSTRIAL (confectionery, chocolates, candy) / Nov. 1[illegible] - Ing. Alejandro Odio, Director of Engineering (24 24 24).** The 80-year old business produces 5,000 tons/year of candies and chocolates for national and international markets. Although a plant visit was not possible at the time, Mr. Odio indicated that there was good opportunity to reduce demand and improve control of the operation. Approx. 95% of the consumption is attributable to approx 550 kW of motor loads that are complex, sequential in operation and not interruptable. However, Mr. Odio pointed out that large motors in the chocolate production line could be interrupted, representing approx. 150 kW. He provided a schematic flow chart of the process. As with most of the plant managers interviewed, Mr. Odio expressed an interest in receiving kW demand graphs for peak days on a regular basis. In addition, he would like assistance from the utility on EMS; they have little time and limited accessibility to technical information and appropriate systems. Mr. Odio is more than willing to participate in the load control project and would like to have new meter installed soon. **ESTIMATED**

CONTROLLABLE LOAD = 150 KW. **GOOD CANDIDATE FOR PILOT PROGRAM.**

18. **RICALIT (fiber cement products) / Nov. 10 - Ing. Harald Luling, Technical Manager (51 08 66), and Ing. Jaime Granados, Assistant to Technical Manager.** This 23-year-old plant produces 2,000,000 sq. mtrs./year of fibrous cement sheets used in a variety of building construction products such as walls, roofing and corrugated tiles. Plant operation is continuous (3 shifts) during 50 of 52 weeks each year. Annual production growth has been approx. 5%/year for the last few years. They had an energy study performed and measures were implemented on the thermal side that resulted in significant savings in bunker fuel. Same production line can be used for various products. Mr. Luling expressed great interest in participating in the load control project and identified several loads that could be kept outside of utility on-peak hours: (1) existing pulper at 75 kW that will be replaced by one rated at 110 kW: (1) lab testing equipment that simulated sun and rain, solar energy is simulated using (180) 250-watt infrared lamp - pumps and lamp represent 89 KW: and (1) impregnating (impregnadora) machine at 150 kW. ESTIMATED CONTROLL-ABLE LOAD: 349 KW. During the meeting, Mr. Luling instructed his assistant to immediately start to maintain operation of the above equipment outside of on-peak periods. Results should be visible in the coming months' load curves for the plant. **GOOD CANDIDATE FOR PILOT PROGRAM.**

19. **MILLER HERMANOS (air separation) / Nov. 10 - Hans Miller, Manager, and Carlos Miller, President.** The plant produces industrial gases from the

air - Nitrogen, Oxygen, Hydrogen and Argon. The Millers stated that it is the only oxygen producing plant in Costa Rica. In 1975, they purchased a hydroelectric plant from ICE and were disconnected from the grid. They currently purchase a limited amount of power from CNFL and are not magnetic tape-metered, so it is not possible to generate kW demand curves. The plant has a constant load for approximately 90% of the time. Some of the largest motor compressors that move approx. 1,500 cubic meters/hour. Plant loads for: Acetylene - 25 kW (const.): Nitrous Oxide = 35 kW (const.); and Hydrogen = 100 kW (once a week). Unexpected power outages cause great disruption; 15 to 20 hours to restart the argon column. They have an older part of the plant which they would like to reactivate using purchased electricity (800 to 900 kW) and are currently negotiating with ICE for service. Consideration might be given to providing this service on an interruptable basis. If this were to be the case, then, **ESTIMATED POTENTIAL FUTURE INTERRUPTABLE LOAD = 900 KW.** Based on the uncertain status of the future electric service, this facility is considered a **LOW TO MEDIUM CANDIDATE FOR PILOT PROGRAM.** In the meantime, it is recommended that an electronic meter be installed in order to start collecting hourly demand data for the plant.

20. **HOTEL AUROLA / Nov. 11 - Mr. Julio Melendez, General Manager (33 72 33) and Mr. Juan Mendez, Chief Engineer.** The 17-story, 201-room hotel was built in 1985 and has 230 employees. It is not magnetic tape-metered and therefore a demand load curve was not available. It's management appears to be very conscious on keeping energy costs low and electric energy represents 2.5% of the hotel's annual operating cost. The entire facility is

served by two 6-ton chillers. Hot water is generated by two Cleaver Brooks 150 psi boilers that run on a total of 2,500 gal. of bunker fuel every 18 days. Except for electric fryers and small kitchen appliances, cooking is done with gas. Energy efficient lighting (fluorescent "type T" 12-watt lamps) is used in the hallways and represent significant monthly energy and demand savings to the hotel. Consideration could be given to studying applicability of power line carrier EMS system to shut the chilled water valves to the fan coil units in each room. The reduction on compressor load would have to be established with a more comprehensive study. Additional consideration might be given to control cooperation of four icemaking machines in the hallways outside of on-peak hours and the duty cycling of the five compressors serving the walk-in freezers. Without a more comprehensive study, this facility is not recommended for the pilot program. **POOR CANDIDATE FOR PILOT PROGRAM.** However, due to the size and nature of the facility, it is recommended that load profile data be obtained to determine potential reduction at times of system peak.

21. **LAMINADORA COSTARRICENSE (steel mill) / Nov. 11 - Pablo Queralt Curco, Production Director (35 18 61 & 35 79 06), Ing. Guy Vincenti, assistant to director, Ing. Manuel Gutierrez, Plant Administrator (management).** The 13,352 sq. mtr. plant was built in 1962. Its main product is 3/8" reinforcing steel bars (2/3), followed by miscellaneous sections of 1/4" bars. The raw material ingots, received by rail (Brazil) are processed at the rate of (60)/hour on a good day. They are then heated to 1200 deg.F in a bunker-fueled furnace and then passed through a series of rollers and extruders to produce the finished products. Although operating

at a 2MW load, production is stopped during utility on-peak hours and the load is brought down to a range of 200-300 kW to operate the overhead crane and miscellaneous secondary equipment. Mr. Vincenti is very interested in participating in the load control project as a way of obtaining better load information in order to further optimize the operation. Mr. Gutierrez showed interest in the project and was more inclined to first have the electronic meter installed. Because direct load control would give the utility the ability to insure that power 1.5 MW be kept outside its peak periods, this plant would be considered a **MEDIUM CANDIDATE FOR THE PILOT PROGRAM.** Installation of the electronic meter might enhance the opportunity to reduce the on-peak load even further.

22. **BENEFICIO/INGENIO VICTORIA (sugar mill & coffee proc.) / Nov. 11 - Ing. Rafael Cartin, Mechanical Superintendent (44 56 38).** The cooperative covers 3,200 hectares and processes sugar cane and coffee from nearby growers. Sometimes, however, the cane has to be brought in from as far as 60 km. The discussion centered on the sugar mill, which has a capacity of 2,500 metric tons/day and employs 115. Although the mill generates its power from bagasse, it often runs short on steam during the processing season of January to May and has to switch over to the electric grid to make up approx. 600 kW of production load. They are currently installing a more efficient 125,00 boiler than should give them the capability to be self-sufficient to handle the 1989 crop. In the meantime, Mr. Cartin feels that with an electronic meter giving a pulse to an EMS, they would be able to reduce on-peak load from 50 to 100 kW and is very interested in participating in the pilot program. **CONTROLLABLE LOAD = 100 KW.**

MEDIUM CANDIDATE FOR THE PILOT PROGRAM. He indicated that, in the future, if they had excess power, selling energy to ICE may be considered.

APPENDIX D: ICE'S SELECTED LOAD MANAGEMENT SYSTEM

Information. . . The Need and The Solution

The Need. . . Information

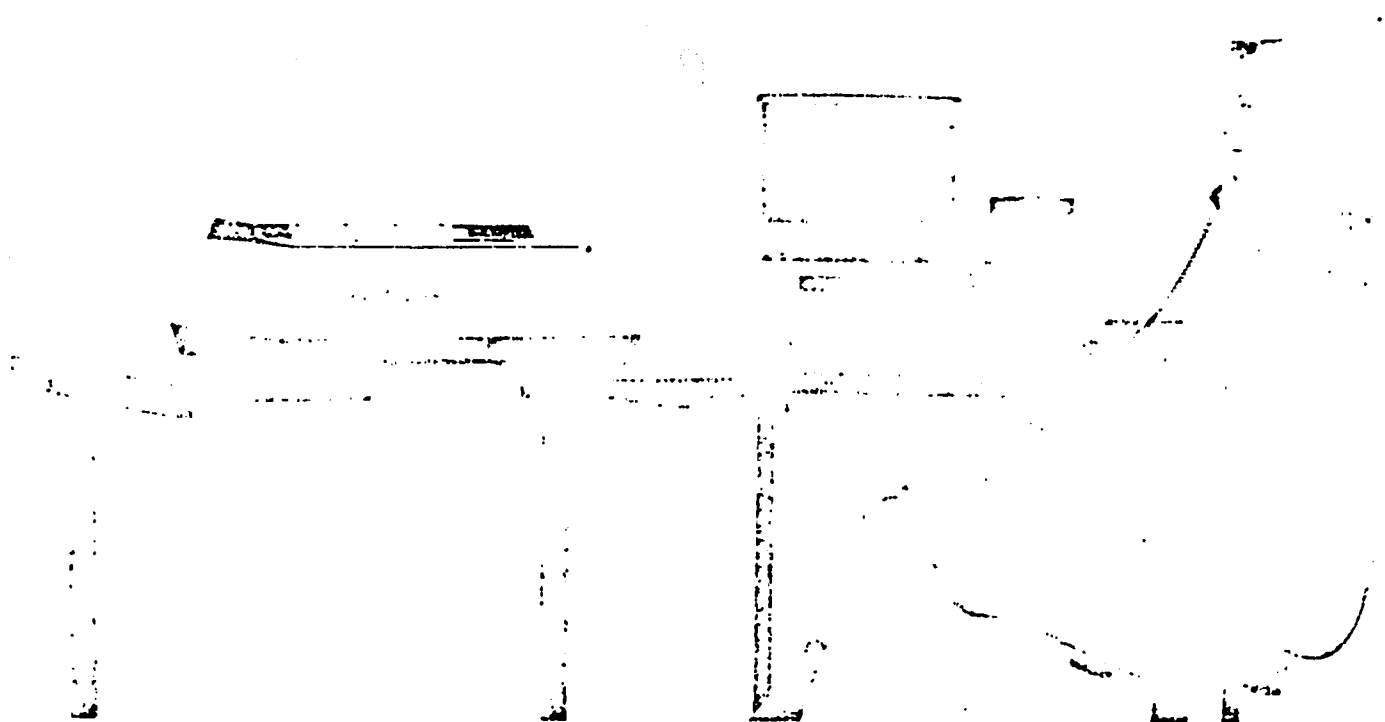
Information. . . accurate, complete, and timely . . . is the basis of any successful business. This truth is even more apparent in the electric utility industry.

Billing meters, major appliances, industry loads, and the equipment in the distribution system are potential sources of volumes of raw data. The need for an automated system to collect and manage this data is evident. In addition, the system must communicate with corporate computers that maintain billing, engineering, rate, and customer service databases.

These are just a few examples of the ever-growing needs in the electric utility industry for information . . . information for business success, policy and rate setting, and decision making.

The Solution. . . The Sentry Solid-State Recording System

PSI's Sentry Solid-State Recording System is the customer-specified and field-proven solution for collecting, editing, and reporting demand, energy, and distribution system data. The basic system consists of a number of Sentry Solid-State Recorders and a Central Station computer. The Central Station may be a stand-alone data collection and report preparation center or a front-end data collector, editor, and condenser for corporate computers.



Sentry Central Station

Capturing and Managing Information with Sentry Recorders

Capturing Information... The Recorders

The field-proven line of Sentry Solid-State Recorders captures pulse data on an interval-by-interval basis from billing meters and other devices. Sentry Solid-State Recorders offer an array of features and options for flexibility in billing, survey, distribution automation, and engineering applications.

Managing Information... The Central Station

The manager of the system is the Sentry Central Station. The Central Station consists of the hardware and software to:

- Simplify master record keeping and to download operating information to the recorders.
- Remotely collect data to reduce meter reading costs and labor.
- Monitor the recorder system to assure complete collection of data.
- Evaluate, edit, and report data to provide accurate end-of-month billing and a complete database for survey reports.
- Convert raw data into reports and into a format compatible with billing or other corporate computers.

The Central Station is based on an IBM Personal Computer AT located at a district, division, or processing center.

The Foundation... The Recorders

The Sentry Solid-State Recorders provide the foundation of PSI's solid-state recording system. The recorders offer the following standard features:

Solid-State Technology

Highly reliable CMOS components provide data and program storage, communications, and overall system control. Wrap-around memory retains data to allow multiple users of the recorder's data and re-reading of data if needed.

Multiple meter inputs allow data recording from up to eight meter pulse initiators. In addition, up to four status contacts and four control relays can be added. Inputs may be from other pulse-initiating devices such as PSI's ProData, an appliance sub-metering system.

Erasable Programmable Read Only Memory (EPROM) provides non-volatile program storage and flexibility in program updates and customized programs.

Timing is provided by a real-time clock that is synchronized to the ac 60Hz. A long-life battery (up to 10 years shelf life) provides weeks of support for both memory and clock in case of power interruption.

Communication Flexibility

Both remote and on-site communication methods are used in the Sentry System. Operating information is remotely downloaded to the recorder from the Central Station over the standard telephone network. This process is called formatting. In turn, data is remotely collected using the telephone network. In addition, the recorder can dial-out to the Central Station to report alarm conditions or other events and to transfer data. A recorder can share a business or residential phone line with the local telephone always having line priority.

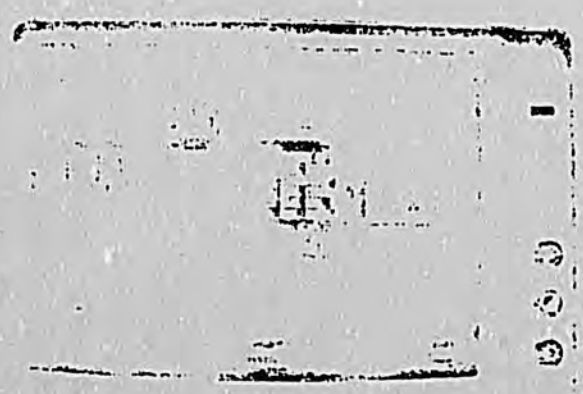
Optionally, the hand-held Sentry 75 Universal Reader/Programmer (URP) provides on-site communication to format recorders and collect data in the field when telephone communications are impractical.

Ease of Operation and Service

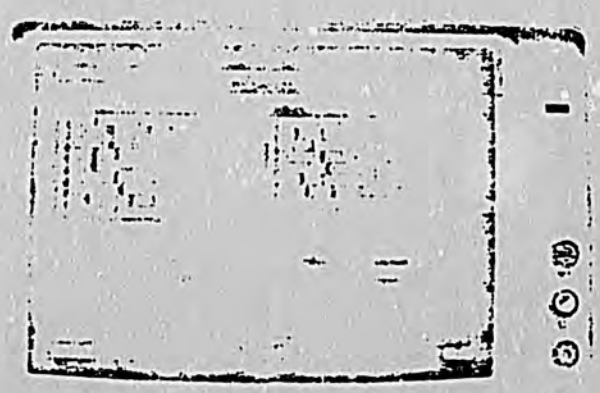
A program-maintained event log stores time/date-stamped messages for such events as ac power interruption, unit accessed, operating information changes, status input changes, and control relay operation.

Self-check diagnostic routines in EPROM provide continuous diagnostics of RAM and program integrity.

Visual indication of the operating state of the recorder and the presence of input pulses is provided by Light Emitting Diodes (LEDs).



Customer Maintenance Menu

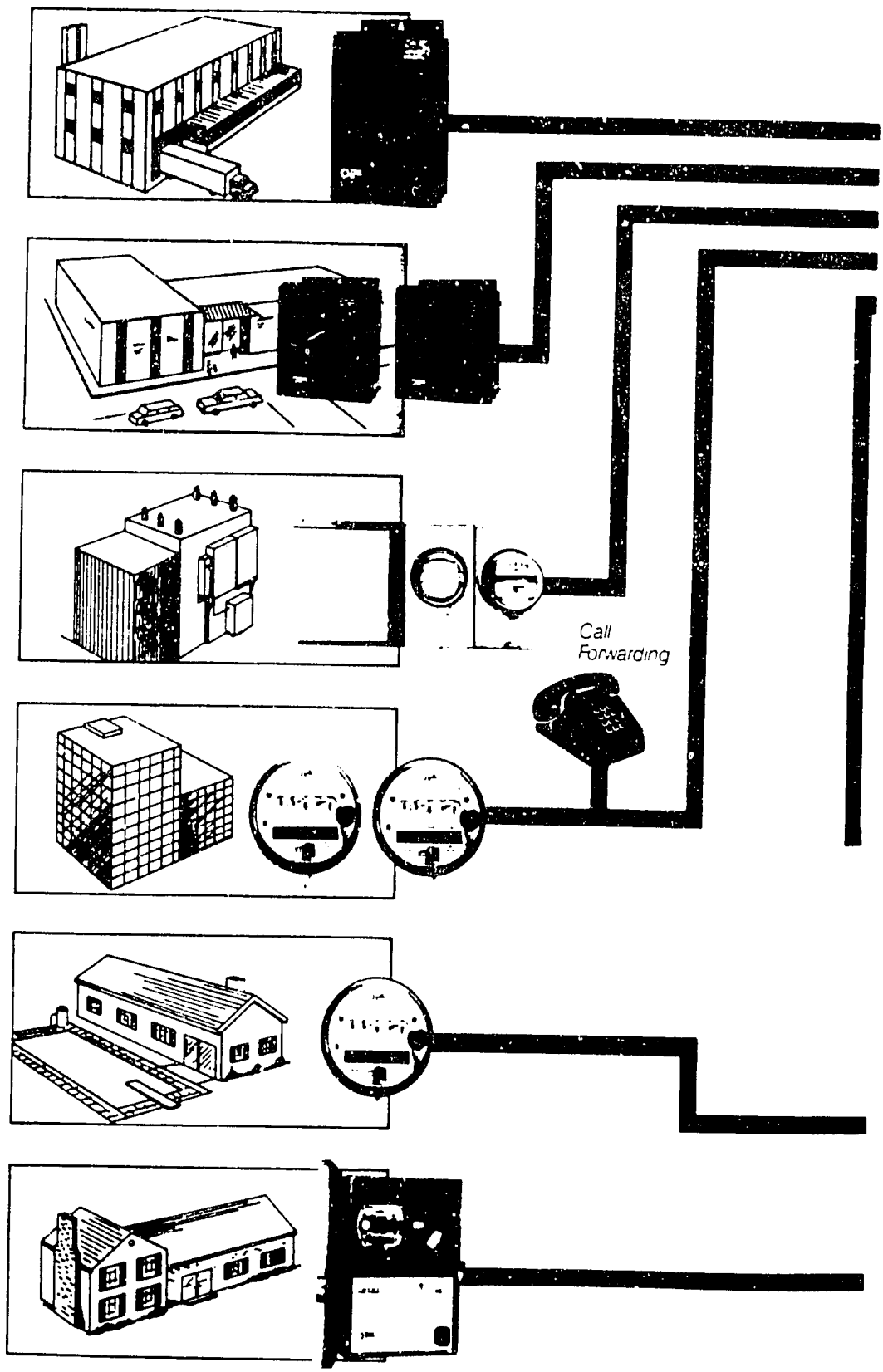


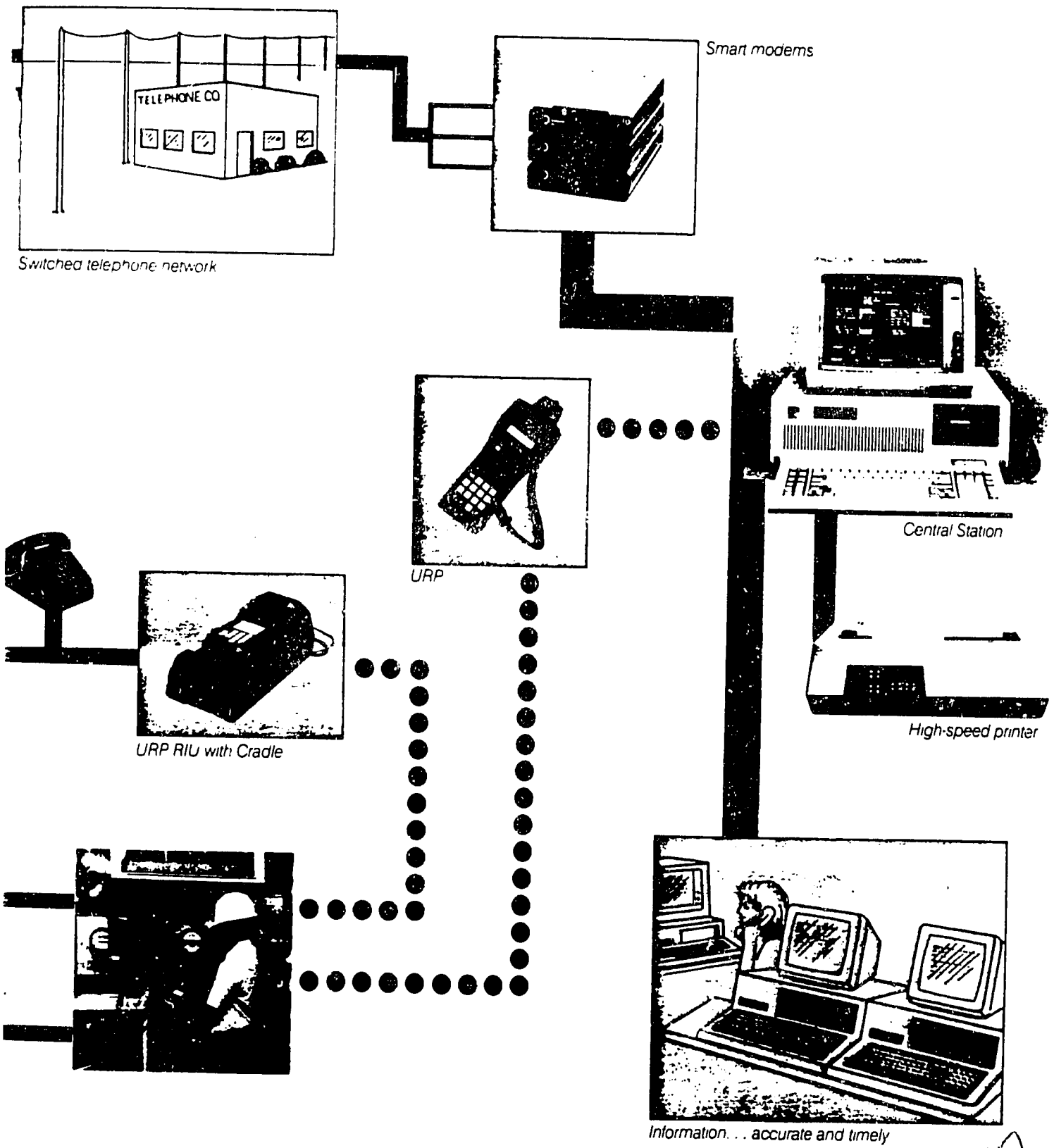
Main Command Menu

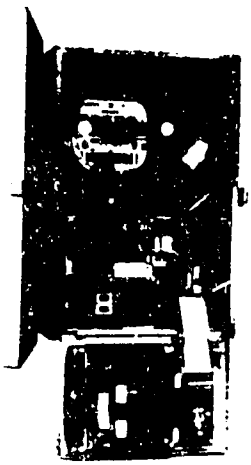
The Flow of Information. . . The Total System

The effectiveness of the total system depends on the efficient use of both the recorders and the Central Station. The following flow of information occurs:

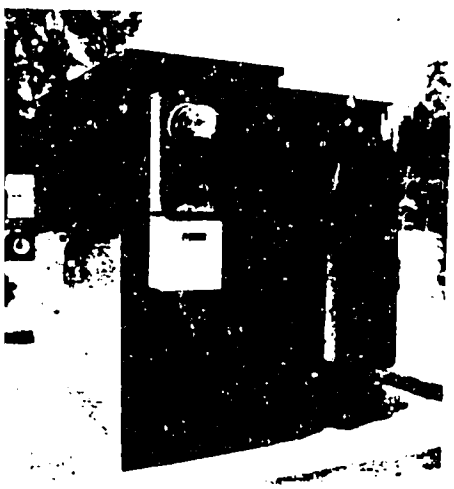
1. Customer and recorder master file information is entered into the data base of the Central Station.
2. Using this master file information, recorders are formatted. Formatting involves passing operating information to the recorder by phone line or URP.
3. Pulse data is collected by the recorder for a period of time. The data is then transferred to the Central Station over the standard telephone network. As an alternative, a Universal Reader/Programmer can be used at the site of the recorder to collect data.
4. The raw pulse data at the Central Station can be edited and validated.
5. Various pulse, energy, and demand reports can be produced from the data.
6. The data is converted into a format recognized by a host computer. As a result, the billing process is accelerated and revenue collection increased.



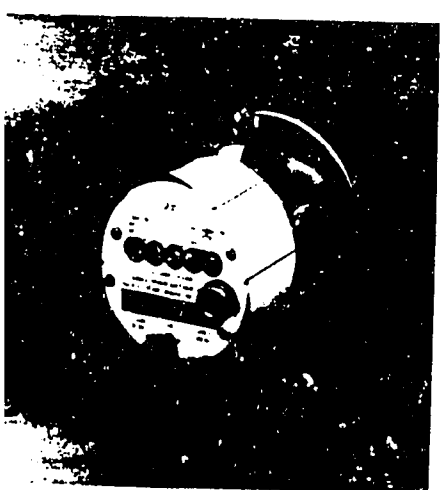

TELEPHONE CO
Switched telephone network
Smart modems
Central Station
URP
URP RIU with Cradle
High-speed printer
Information. . . accurate and timely



Sentry 100-ST in enclosure with meter



entry 100



ntry 100 Integrated Meter Recorder

Recorder Options

In addition, certain models of the Sentry 100 series of recorders provide the following optional features.

Remote Meter Dial Reading
The PSI Sentry 65 Optical Dial Encoder provides remote reading of the meter dials. Up to eight Dial Encoders can be read by a single recorder.

End-use Device Surveying
Submetering information for appliances or other end-use devices can be obtained with the PSI ProData System. ProData ADD I is based on power-line carrier technology while ProData ADD II is a hard-wired implementation. A volt-hour transducer is also available.

Input/Output Capabilities
The optional Input/Output Module provides one serial data port, four output control relays, and four status input points.

External Display
The optional Display Module provides on-site reading of date and time, peak pulse counts, and other totals.

Scheduled Dial-Back
Allows the Recorder to dial back to the Central Station for data dump on a pre-determined schedule.

Call Forwarding
Enables recorder to share existing phone line with no interruption of phone service.

Recorder Models

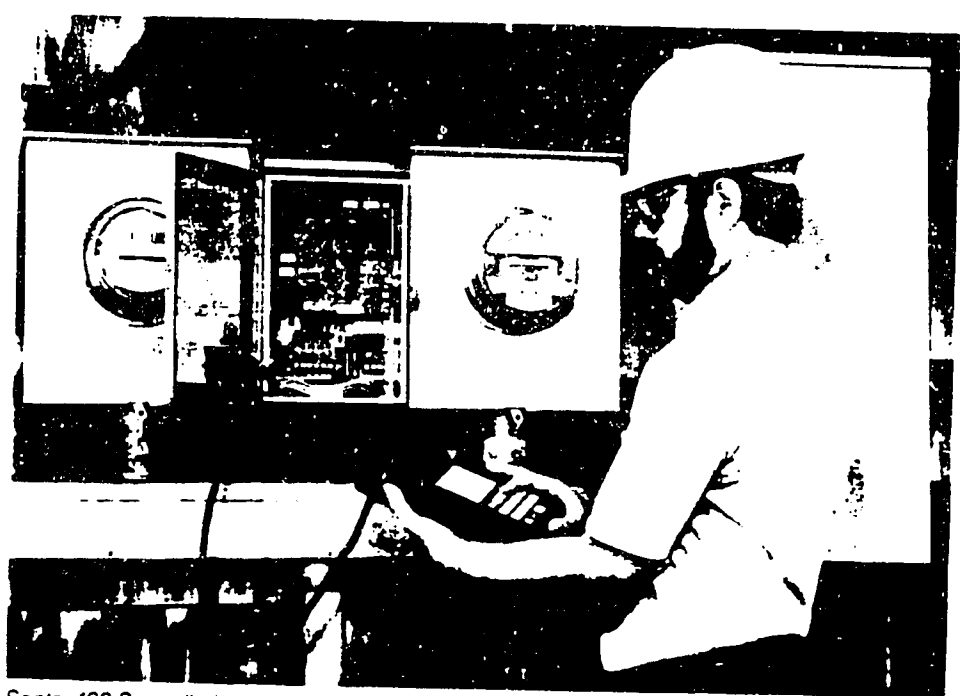
PSI offers four models of the Sentry Solid-State Recorder:

The Sentry 100 Recorder is the top of the Sentry line. This recorder provides all standard features and can be equipped with all optional features.

The Sentry 100-S Survey Recorder is a trimmed-down version of the Sentry 100. This recorder accepts up to four 2-wire inputs or two 3-wire inputs.

The Sentry 100-ST Survey Recorder provides direct chassis replacement of magnetic tape demand recorders, fitting inside the magnetic tape enclosure. This recorder supports all of the features of the Sentry 100-S Survey Recorder.

The Sentry 100-IMR Integrated Meter Recorder can be retrofitted under the cover of existing meters. The Sentry 100-IMR is available as a time-of-use register, totalizer, survey recorder, and billing recorder.



Sentry 100-S installed on residence

15V

The Manager. . .
The Central Station

The Manager. . .
The Central Station

The Sentry Central Station is truly a flexible information management tool in itself or as a front-end to corporate computers. The Central Station manages the collection, reporting, and interpretation of information.

Central Station Hardware

The basic Central Station hardware is a personal computer that can provide sophisticated processing capabilities to many levels and points in the organization.

Hard disk storage provides rapid, on-line storage and manipulation of large amounts of data, diskette storage provides reliable and efficient back-up of master and meter data files.

A high-speed character printer provides the means to print pulse, energy, demand, maintenance, and management reports. Modems provide the link to the telephone network for communication with the recorders.

Central Station Software

The Central Station software is a complete set of PSI programs that include the following functions:

- **Overall System Control**
  Monitor and Scheduler Programs oversee the multiple processes and schedules in the system.
- **Master File Maintenance**
  Creates and maintains recorder and customer master file information.
- **Recorder Communication**
  Used to initially format recorders and, subsequently, to collect interval-by-interval data and the event log. Data can be collected on demand, on a scheduled basis, and by the recorder dialing in.
- **Editing Data**
  Provides easy editing and analysis of the raw pulse data and manually entered readings.
- **Reporting**
  Provides a variety of pulse, energy, or demand reports from the data of single recorders or from totalizations and various operational and database maintenance reports.
- **Data Formatting**
  Converts raw pulse data into the host computer compatible format. Formatted data is transferred via tape or by direct connection to a host computer.
- **Spread-Sheet Interface**
  A data file conversion program provides an interface to industry-standard spread-sheet software, such as SuperCalc and Lotus 1-2-3.

In addition, PSI will provide custom programming to meet the specific requirements of a customer.

Communication Flexibility . . . The Universal Reader/Programmer

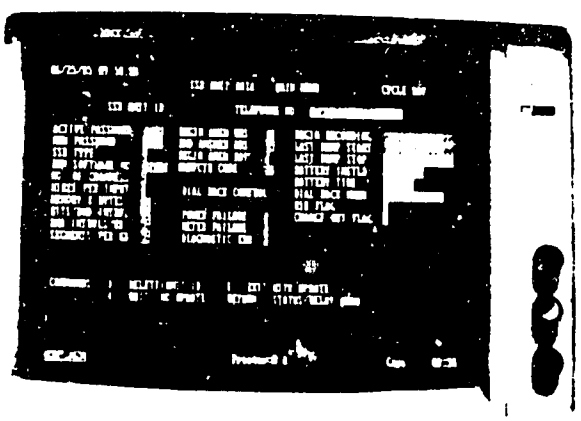
Communication flexibility is provided by the Sentry 75 Universal Reader/Programmer (URP) and Remote Interface Units (RIUs). The URP is a hand-held, battery-powered device that provides data collection at the site of the recorder. Once data is collected, it can be transferred to the Central Station by direct connection, by voice-grade telephone lines, or through a Remote Interface Unit. In addition, master file information can be loaded into the URP to enable on-site formatting of recorders.

Smart Remote Interface Unit

The S7100 Smart Remote Interface Unit (RIU) is a computer that collects data from URPs or Plain RIUs and stores it for eventual transmission to the Central Station at the availability and command of the Central Station. Therefore, collection of data can be concentrated.

Plain Remote Interface Unit

The S85 Plain Remote Interface Unit (RIU) adds the flexibility to transfer data from a URP in the field over telephone lines to a Smart RIU or a Central Station.



Menu-driven system

ENERGY USAGE LISTINGS (KWH)

ACCOUNT NUMBER 37654000 REPORT START 07/21/85 00:00
DEMAND METER NUMBER 0000017 REPORT STOP 07/25/85 00:00
SYSTEM DATE 07/26/85 09 17

INDIANAPOLIS

1 HOUR ENDING	JUL 21	JUL 22	JUL 23	JUL 24	JUL 25
100	14436.0	14560.0	13468.0	13328.0	14208.0
200	14596.0	14520.0	13582.0	13568.0	14319.0
300	14304.0	13150.0	13468.0	13387.0	14330.0
400	13004.0	13670.0	12042.0	12000.0	14428.0
500	14636.0	13870.0	13836.0	11758.0	14008.0
2300	14306.0	14360.0	13468.0	13328.0	14008.0
2400	13006.0	14960.0	13468.0	13568.0	11608.0
DAILY KWH:	358869.0	355419.0	314769.0	310769.0	357

TOTAL PULSE COUNT = 1556648 TOTAL KWH = 311329E

Interval Demand Report